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ON DIABETES

AND

Its Connection with Heart Disease.

BY

JACQUES MAYER, M.D.

(Vienna), Carlsbad.

ON DIABETES AND ITS CONNECTION WITH HEART DISEASE.

A GLANCE at the literature of diabetes, which, more especially since the memorable discoveries of Claude Bernard, has attained very large proportions, shows us that singularly little is as yet known on certain affections of the heart and blood-vessels which are apt to occur in the course of that disease. This may, perhaps, be accounted for by the circumstance that those who have occupied themselves with investigating the pathology of diabetes, seem to have given their chief attention to the examination of those organs which experimental physiology had shown to be more particularly involved in its production.

Thus we find that Seegen,[1] in his book on diabetes, containing a record of 140 cases, says but little on the condition of the heart and blood-vessels in his patients. In one of his cases, that of a man aged fifty-eight, the right side of the heart was found hypertrophied; in another there was a feeling of congestion in the cardiac region; a third was subject to angina pectoris, although the heart was believed to be normal; in a fourth he found slight insufficiency of the mitral valve, and, finally, in a fifth case, a systolic murmur was heard over the left ventricle. In other six cases the heart is simply stated to have been normal. This author does not say a word about any anatomical lesions of the organs of circulation in diabetes in his chapter on morbid anatomy, where reference is made to thirty cases examined by Rokitansky and a few other anatomists.

In Cantani's clinical lectures on diabetes[2] there is also a great dearth of information about affections of the heart and blood-vessels. In 220 cases referred to by him, there was only

one with valvular disease, which latter, however, had already existed before symptoms of diabetes had set in. In 150 cases no mention whatever is made of the physical condition of the heart. Out of five instances in which an autopsy was obtained the heart was found small and atrophied in four, while in one its size was normal, but the right ventricle was found somewhat dilated.

Again, Senator[3] states that no prominent or frequent symptoms are to be observed in the sphere of the heart and blood-vessels in diabetes. In very obese subjects affected with diabetes the heart has been found surrounded by fat, as is also seen in others who are not diabetic,[4] after protracted ill-health; while, where nutrition in general had suffered, it has been found atrophied. The arteries have sometimes shown atheromatous degeneration, but not very frequently, and Dickinson thinks this process to be rare in diabetics.

Donkin,[5] following some other English authors, has drawn attention to atrophy and fatty degeneration of the cardiac muscle found in diabetes. He observed that, in consequence of insufficient propelling power of the heart, hydrops occasionally supervened, or that there was sudden death by syncope. There was frequently great wasting of muscular tissue, and the pulse was very small and quick.

R. Schmitz[6] describes a group of symptoms in advanced cases of severe diabetes, consisting of shortness of breath, sudden anorexia, vertigo, somnolence, fullness in the head, and liability to fainting. Such signs he refers to relaxation and fatty degeneration of the heart. The pulse is soft and small; it is sometimes accelerated, but in other cases exceedingly slow; the apex-beat is always feeble, and often scarcely perceptible; the sounds of the heart and of the great vessels are feeble, and very indistinct. Such a condition of the heart Schmitz has ascertained in 80 out of 109 diabetic patients.

Leyden[7] has made some interesting remarks on asthma in diabetes, which point to a very different condition. The signs which he has observed are those habitually found in cardiac asthma. There are attacks of dyspnœa, with palpitations and cardiac debility, occurring sometimes at a comparatively early period, where the diabetes does not seem far advanced, either in duration or intensity. According to Leyden, mental emotions are the exciting cause of such attacks. Asthma

and cardiac debility may also arise from certain affections of the lungs.

In one of Leyden's cases the diabetes took a rapidly malignant course, and led to extensive lung-disease, with well-marked attacks of cardiac asthma. The autopsy showed that these attacks had been owing to hypertrophy and dilatation of the left ventricle, with fatty degeneration to an almost minimal extent.

Lecorché[8] has published some interesting observations on endocarditis, which he has seen, in a comparatively short time, in fourteen cases, as a complication of sub-acute and chronic diabetes. The age of the patients varied from twenty-seven to seventy-eight years; not one of them had suffered from rheumatism, or had been a habitual drunkard. The inflammation generally affected the mitral orifice, and only once the aortic orifice. In two cases the arteries showed the atheromatous change. The symptoms of diabetic endocarditis were the same as those of the common form of that disease, *viz.*, a feeling of oppression, palpitations, intermittent pulse, œdema, and some other well-known sequelæ. There was a systolic murmur audible at the apex, but sometimes this only appeared after irregularity of the pulse and œdema had already been present for a considerable time. According to this author, the cause of the endocarditis is to be found in the continued contact of the saccharine blood with the inner surface of the heart.

Vergely[9] has made some noteworthy observations on angina pectoris in four cases of diabetes which were in the first stage of the disease, and where nothing abnormal could be discovered in the heart. He believes the two affections to be etiologically connected.

In Frerichs'[10] book on diabetes the affections of the heart occurring in the diabetic have not been treated of, either from a clinical or an anatomical point of view. He has, however, observed sclerosis of the vessels in diabetes, and says:[11] "I have frequently seen sclerosis of the vessels, sometimes only of the coats of the arteries, at others with valvular disease which was combined with it, and I therefore consider it probable that there is a connection between the two conditions. They occurred in protracted forms of diabetes, in which I could follow the gradual and slow evolution of these changes in the heart and vessels, particularly such as were complicated with gout."

With regard to anatomical lesions he states[12] that the heart was frequently found small and atrophied, either pale or brownish red, and weighed from 4 to 6½ ounces. Valvular disease was repeatedly discovered, and it is worthy of note that during the course of diabetes chronic arteritis is apt to become developed.

If we add to this that Frerichs attributes some of the symptoms of diabetic coma to cardiac debility, and the sudden death which he sometimes observed to paralysis of the heart, we have stated everything of what Frerichs regarded as a connection between diabetes and heart disease, independently of such as is caused by certain diseases of other organs, such as the kidneys.

It will be seen from the preceding remarks that the clinical symptoms, as well as the anatomical lesions which have been described, have almost exclusive reference to cases of diabetes which have lasted for some considerable time. There are as yet no observations based on carefully continued physical examination of the heart, from the very commencement to the final termination of the disease. This is probably owing to the circumstance that diabetic patients as a rule enter the hospital only after the disease has greatly undermined the powers of the system generally.

It would appear to be easier to approach this side of the question in private practice; but there likewise the matter has attracted comparatively little interest. Even Pavy,[13] who has done so much towards the elucidation of the pathology of diabetes in its theoretical as well as practical aspects, has, in his report on 1360 cases of diabetes which he brought, about three years ago, before the British Medical Association, when treating of the physical examination of the organs in diabetes, only spoken of the condition of the liver in that disease.

With regard to my own observations on this point, I may here refer to a paper[14] which I published nine years ago on certain symptoms which I had observed in cases of diabetes complicated with obesity. These patients were apt to be suddenly taken with dyspnœa, although not to an alarming extent; they complained of pain and a feeling of oppression in the cardiac region, the pulse was abnormally quick, beating at a rate of 120 to 140 in the minute, with marked want of rhythm (delirium cordis). The pain sometimes spread from the heart to

the shoulder, or to the left arm. In fact, the symptoms were analogous to those of angina pectoris.

Attacks of this kind have come under my notice in the initial stage, as well as in the further progress of the disease, but more frequently at an advanced period, after the obesity had more or less subsided; and physical examination of the heart showed mostly dilatation of the ventricles.

I did not then think there existed an etiological connection between these symptoms and the diabetic process, or more strictly speaking, the saccharine blood, more especially because the same cardiac symptoms and physical state of the heart, on which Leyden [15] has thrown a flood of light, have also been frequently observed in cases of obesity without diabetes.

Subsequently, however, I discovered similar symptoms in diabetes uncomplicated with obesity; and I then thought it would be important to ascertain accurately, and as far as possible from the very beginning of the disease, the physical condition of the heart in every single instance which might come under my observation. I expected to arrive at some interesting results in this matter, as the waters of Carlsbad attract year after year a very large number of patients suffering from diabetes, who belong to all classes of society, the cases being of all the various degrees of intensity. I am fully aware that observations of this kind cannot claim the same degree of accuracy as those made in hospital practice; but I have been anxious to atone for this want as far as possible by written notes taken at the time. The number of cases being comparatively large, some degree of value may perhaps be attached to these observations.

Observations made from 1879 to 1888.

In these I have endeavored to ascertain whether an etiological connection could be traced between heart disease in its clinical and anatomical aspects, and the principal symptoms of diabetes, *viz.*, glycosuria and azoturia. From this point of view I have examined altogether 380 cases, which are tabulated with regard to sex and age as follows:—(See page 8.)

It appears from this table that the large majority of cases occurs between the ages of forty and sixty; indeed, out of 380 patients, 248 belonged to those periods of life.

Age.	Absolute Number.			Percentages.		
	Male.	Female.	Total.	Male	Female.	Total.
Up to 10 years.....	0	1	1	0	0.26	0.26
From 10 to 20	1	3	4	0.26	0.79	1.05
" 20 to 30	3	5	8	0.79	1.31	2.10
" 30 to 40	29	16	45	7.64	4.20	11.84
" 40 to 50	99	22	121	26.04	5.80	31.84
" 50 to 60	76	51	127	20.00	13.42	33.42
" 60 to 70	51	12	63	13.41	3.17	16.58
" 70 to 80	7	4	11	1.84	1.05	2.89
Total.....	266	114	380			

It is a matter of everyday experience that the course of diabetes is more rapid and unfavorable in youth than in advanced age. This accounts for the circumstance that by far the largest number of my cases, *viz.*, 337, were at the time of observation in the first stage of the disease, and merely a fraction, *viz.*, 43, in the second stage.

First Stage.....Males, 241.....Females, 96.
Second Stage.....Males, 25.....Females, 18.

The female sex shows a far higher percentage in the second stage than the male.

In this, as in previous papers on this subject, I prefer speaking of "stages" rather than of a "mild and severe form," as further experience has shown me that the former classification meets the facts of the case far better than the latter. Out of forty-three cases of the second degree, twenty-six merged, as it were, under my own eyes from the first into the second stage.

If we leave out of sight for the present the degree of intensity of the malady and direct our attention to the general appearance of the patients, we notice certain distinctive features in them which, although they are not absolutely constant, are yet sufficiently characteristic to enable us to distinguish three well marked types of diabetics.

We have to do, then, 1st, with patients of a feeble and delicate constitution, a more or less pale complexion, and a timid, anxious expression.

2d. With patients who, on the contrary, have a vigorous and healthy appearance, a florid complexion, and a lively and animated expression.

3d. With obese patients, some of whom are pale and sallow, while others have either a ruddy or a livid complexion.

In the beginning of the complaint, or soon after it has commenced, the physical examination of the heart and vessels hardly ever shows, in any case belonging to the three types just mentioned, that the sugar which is circulating with the blood, or any increased production of urea which may have occurred, have had an unfavorable influence upon the cardiac muscle. Auscultation and percussion reveal the same signs as in patients of a similar condition who are not subject to diabetes.

After the malady has, however, lasted for some time, the physical signs undergo certain changes, which come on sooner or later, according to individual circumstances. To these I now proceed to direct attention.

In cases belonging to the first type—that is, in those of a more or less anæmic and feeble constitution—I have occasionally seen endocarditis supervene, after some little time, as described by Lecorché, but much less frequently than this author, and not so much in patients of an advanced age.

In other cases of the same type the well-known symptoms of cardiac debility came on suddenly, while the physical signs found on examination of the heart did not show that any morbid changes had occurred in the endocardium, or that the volume of the muscular substance of the organ had been altered.

We may, however, conclude from the quality of the pulse, which is very easily compressible and of varying frequency, as well as from the weakness of the heart's sounds and the occasional presence of the so-called, "galloping murmur" (which latter Fraentzel[16] looks upon as indicating cardiac debility), that in such cases the functional power of the heart is lessened, and that this is owing either to atrophy or to retrogressive changes in the muscular fibres—that is, fatty degeneration.

In a further number of cases the physical examination of the heart, which had in the beginning shown nothing abnormal, revealed, as time went on, dilatation of the organ, which for a period did not seem to lead to any very striking symptoms, but which was, as soon as an exciting cause of some sort had acted, followed by severe dyspnœa and delirium cordis.

Cases of this kind are analogous to those of overstrain of the heart having a protracted course, in which Leyden[17] has,

with Da Costa, distinguished a first stage of functional disturbance of the heart's action, and a second period of organic lesion, with dilatation of the ventricles. In the cases to which I am now referring, however, the functional symptoms of the first stage are not so clearly marked as in the other class, although Leyden [18] says pertinently, when speaking of the commencement of that cardiac affection:—"In private practice we shall only in very exceptional instances succeed in observing the first onset of this condition. The symptoms are then so insignificant, and become so gradually developed, that the patient does not at once seek medical advice, but only subsequently reports the initial symptoms from recollection."

With regard to diabetic patients of the second type, I have found, in the majority of cases, after the malady has lasted for a variable time, a well-marked group of symptoms pointing to the development of cardiac hypertrophy. The complexion then becomes reddish, the mucous membrane of the mouth and the conjunctivæ is congested, the eyes are lustrous, and the carotids pulsate strongly as soon as there is the slightest emotional excitement. Vertigo, headache, and singing in the ears are frequently complained of. The first signs of shortness of breath appear habitually after a somewhat abundant repast; walking exercise after meals causes discomfort; there is pain in the stomach and belching, and the action of the bowels becomes irregular. Sleep is broken, and often disturbed by a dry cough.

The pulse is full and strong, but does not show unduly high tension. It is regular and not accelerated, but, on the contrary, sometimes rather retarded.

The physical examination of the heart shows a strong impulse, which extends over several intercostal spaces. The apex-beat is either within or without the mamillary line towards the left side, mostly in the fifth or sixth intercostal space. Percussion shows an enlarged sphere of dullness upwards and downwards, and less so in the transverse direction. The heart's sounds are loud and normal. In short, we have to do with idiopathic hypertrophy of the left ventricle, which has become gradually developed.

Further observations have shown me that this condition of the heart may persist for a number of years without producing much systemic disturbance, provided the patient avoids

over-exertion and emotional excitement, is temperate in his habits, more especially with regard to alcoholic stimulants, and is careful to take regular exercise. On the other hand, where there is impaired nutrition; where, as is sooner or later always the case in diabetes, the food taken does not suffice to supply the wants of the system; where, therefore, the structure of the organs themselves is called upon for the maintenance of work, or where sedentary habits of life promote arterio-sclerosis, there the functional activity of the heart necessarily becomes lessened. The cardiac muscle is then relaxed and dilated, and sooner or later severe symptoms of disturbed balance of power make their appearance. Signs of cardiac debility, in fact, are then of cardinal importance in the further progress of the disease.

I have come to the conclusion that insufficient cardiac force, with dilatation of the ventricles, is, in a large number of cases of diabetes, traceable to more or less fully developed hypertrophy of the muscular substance. If it were objected to this, that alarming cardiac symptoms in diabetic patients of the second type occur sometimes with extreme suddenness, without any hypertrophy having been ascertained previously, I would reply: 1st, that it is sometimes difficult or impossible to recognize this during life, inasmuch as enlargement of the lungs may be an impediment; 2d, that in cases which progress rapidly, the increased volume may not be sufficient to cause marked signs, while the symptoms which have been described above may occasionally be overlooked.

It is, however, by no means necessary that hypertrophy should be invariably followed by dilatation. Even a vigorous muscle may waste away if insufficiently nourished. Moreover, I have seen a few cases where, after hypertrophy of the left ventricle had indubitably manifested itself, in the progress of diabetes, symptoms of cardiac debility appeared, and yet the physical signs of dilatation were absent. This can only be accounted for by assuming that the muscular substance, which was at first hypertrophied, has become atrophied, and that in consequence of a diminished blood-supply the capacity of the heart could be lessened without dilatation being produced.

In patients of the third type, where diabetes is complicated with obesity, I have only ascertained a single new point tend-

ing to explain the morbid phenomena on the part of the heart. It seems to me that, independently of the influence of accumulation of fat on and in the interstitial tissue of the muscle, as well as of arterio-sclerosis, which is so frequently present, the diabetes as such intensifies the degree of the heart-affection, and accelerates the eventual termination of the illness.

It is therefore seen from the preceding remarks that enlargement of the heart, owing either to hypertrophy or dilatation, occurs much more frequently in diabetes than might be assumed from the scanty information which has hitherto been available in the literature of the subject.

In 82 out of 380 cases of diabetes which have been under my care, the condition which I have just described has been present, without any other pathological change which could have led to it.

I now subjoin a few cases with the view of illustrating my statements.

CASE I.—G. R., a merchant, aged forty-seven, comes from a healthy family. He was found to be diabetic nine months ago, the quantity of sugar amounting then to 4.7 per cent.

I first saw the patient on June 19, 1879. He is of medium height, bones large, muscles well developed, and fat moderately so. The face was congested; nothing abnormal could be discovered in the lungs and nervous system. The pulse was full and strong, of medium tension, regular, 64 per minute. The heart's dullness extends from the upper margin of the third down to the sixth rib, slightly beyond the mamillary line; towards the right it does not project beyond the edge of the sternum. The apex-beat was strong, and found in the fifth intercostal space, a little outside of the mamillary line. The liver and spleen appeared normal. The patient complained of constipation, headache, and rather frequent attacks of vertigo, with fullness and discomfort in the stomach after meals.

June 21st.—The quantity of urine in the twenty-four hours amounted to 2¼ quarts; spec. grav., 1,034; 4.3 per cent. of sugar=1419 grains. No albumin.

I came to the conclusion that the diabetes had existed for some considerable time before it had been discovered, for although the patient had followed for many months a strict diet, the sugar only disappeared from the urine after twelve days of an exclusively nitrogenous diet. Within the next five years the patient was on three separate occasions under my care for four weeks consecutively, *viz.*, in 1881, 1882, and 1884.

In 1881 I observed the case from July 15th to August 12th.

The patient stated that during the past two years he had been fairly well, except that he had, after rather plentiful repasts, been troubled with headache, vertigo, and some little shortness of breath. Nevertheless, the physical examination showed that the hypertrophy of the left ventricle had increased. The sphere of dullness was greater longitudinally, as well as transversely. The apex-beat was about 0.7 of an inch outside the mamillary line in the sixth intercostal space. The appearance of the patient was not changed; there was no albumin in the urine; he was still in the first stage of the complaint. The spleen and liver appeared enlarged, the spleen was also hardened.

July 7th to August 3d, 1882.—There is now, in addition to the earlier symptoms, broken sleep, frequent sensations of heat in the cardiac region, and dry cough at night. The condition of the heart is the same as before.

July 9th.—Quantity of urine in the twenty-four hours, 61 ounces; spec. grav., 1,032; 2.5 per cent. of sugar=734 grains. No albumin.

August 1st.—Quantity of urine, 57 ounces; spec. grav., 1,028; 0.8 per cent. of sugar=222 grains. No albumin.

May 17th to June 20th, 1884.—Patient rather emaciated, complains of frequent dyspnœa and palpitations. During the last six months there have been repeated attacks of angina pectoris.

The pulse is permanently accelerated, 80 to 90 per minute, feeble, irregular, of low tension, the radial arteries are narrow. Apex-beat in the seventh intercostal space, soft and easily compressible. The area of dullness at the left side is increased in all directions; on the right side, at the base of the sternum, it is perceptibly enlarged. The heart's sounds are pure, but feeble. The liver and spleen have become more enlarged.

May 19th.—Quantity of urine in the twenty-four hours, 40 ounces; spec. grav., 1,036; 4.8 per cent. of sugar=936 grains. Traces of albumin, no casts.

During the time the patient was now under my care he had a severe attack of cardiac insufficiency, after taking a walk subsequently to a meal. The attack was one of cardiac asthma, and lasted about thirty-five minutes.

June 18th.—Quantity of urine, 52 ounces; spec. grav., 1,031; 1.6 per cent. of sugar=404 grains. No albumin.

Case II.—M. S., aged fifty-six, a merchant, from New York, comes from a healthy family without hereditary tendencies. Diabetes for the last three years. He had a slight attack of pneumonia twenty years ago; since then he has from time to time suffered from dyspepsia, which he ascribes to drinking too freely of iced water. During the last two years he has often had headache, and after drinking tea or coffee a feeling of discomfort in the cardiac region. His occupation has been

laborious and exciting; he has slept badly. Polyuria and polydipsia have lately somewhat diminished. There have been symptoms of dyspepsia, and sluggish action of the bowels.

July 1st, 1882.—Patient is of medium height, muscles well developed, bones normal, complexion florid, fat not too abundant, most teeth are gone, those still present are decayed. No *fœtor ex ore.* Lungs normal. The liver projects about 0.7 of an inch beyond the ribs, and is of medium consistency. The spleen is a little swollen, hard, and tough.

Pulse 60, strong, full, regular, tension somewhat increased, but no rigidity. Dullness at left side very marked and increased, reaching from third to sixth rib; apex-beat in sixth intercostal space, about 0.39 of an inch beyond the mamillary line. Impulse strongly resisting, dullness at right side not increased. Heart's sounds loud, normal.

July 3d.—Quantity of urine, 57 ounces, spec. grav., 1,038; 2.25 per cent. of sugar=607 grains. No albumin.

July 27th.—Quantity, 55 ounces; spec. grav., 1,028. No sugar or albumin.

Case III.—L., aged forty-five, a merchant, from Hungary, has indulged in sweet dishes; had catarrh of the bladder three years ago, but not now. Diabetic symptoms for several years. Diabetes diagnosed six months ago, with 5 per cent. of sugar.

Until a year ago he felt well, and could follow his occupation, which was very laborious; had only from time to time headache and vertigo. After a full meal, more especially if washed down with wine and coffee, there is a feeling of fullness and pressure about the heart, but no palpitations. Cause unknown. For the last twelve months his strength has gradually diminished, and he has rapidly wasted away; after muscular efforts there is dyspnœa and palpitations.

August 24th, 1882.—He complains of fatigue, which is easily induced, weariness, and somewhat increased thirst, as well as dryness in the mouth, broken sleep, frequent attacks of dyspnœa, with severe palpitations, dyspepsia, and cough.

Short stature, bones rather strong, muscles flabby and thin; florid complexion, skin dry, breath smells of acetone, teeth decayed, sight feeble. Slight bronchitis, nothing wrong with lungs. Pulse 80, regular, easily compressible; radial arteries narrow, dullness increased on right, as well as on left side, on the left reaching about 0.7 of an inch beyond the mamillary line, on the right extending about 0.39 of an inch beyond parasternal line. Apex-beat in sixth intercostal space, rather broad, soft, and easily compressible. Impulse on left side slightly, on right side more strongly resisting. Liver enlarged, and tender on pressure.

August 26th.—Quantity of urine, 57 ounces; spec. grav., 1,037; 6.5 per cent. of sugar=1755 grains. No albumin.

August 29th. —Diet having been rigidly enforced for three

days, the quantity has come down to 52 ounces, spec. grav., to 1,034; 3.3 per cent. of sugar=817 grains. No albumin.

September 18th.—Quantity, 50 ounces; spec. grav., 1,033; 2.6 per cent. of sugar=624 grains. No albumin.

The result of the last analysis, after a six days' strict nitrogenous diet had been enforced, showed that the patient was, as far as the elimination of sugar was concerned, in the second stage, or at least in an advanced period of the first stage of diabetes.

In 1883 he was again under my care from June 21st to July 15th.

Emaciation had then made further progress. The symptoms of diabetes and those of cardiac insufficiency were about proportionate in degree. There are more frequently severe attacks of asthma; pulse 90 to 95, feeble. The physical examination of the heart shows that the dilatation of both ventricles has still further increased.

June 23d.—Quantity of urine, 54 ounces; spec. grav., 1,040; 7.2 per cent. of sugar=1830 grains. No albumin.

July 15th.—Quantity, 56 ounces; spec. grav., 1,038; 4.6 per cent. of sugar=1276 grains.

Case IV.—Mrs. J., aged fifty-three, from S., England, a clergyman's wife. She had in former years frequently suffered from boils, and ascribes her illness, which was diagnosed twelve months ago, to severe grief. She has five children, all of them healthy. No hereditary tendency ascertainable. Diabetic symptoms, more especially polyuria and polydipsia, only slightly marked. She is easily fatigued after exercise, and disinclined for mental work.

August 4th, 1883.—Patient looks strong and vigorous, muscles and fat well developed. Complexion healthy; the conjunctivæ rather congested. She complains of frequent headache and occasional attacks of vertigo. When sitting for any length of time, respiration becomes uneasy; no cough. She finds it necessary to change her position frequently at night.

Pulse 62, full, strong, rather above medium tension, regular, dullness of left side increased upwards, downwards and outwards, extending beyond mamillary line about 0.39 to 0.5 of an inch. Apex-beat in sixth intercostal space, outside the mamillary line, very broad and powerful. Impulse likewise strong. Heart's sounds pure and loud. Liver somewhat enlarged, feels on inspiration rather harder than usual, spleen somewhat enlarged. Pressure and fullness in stomach rather frequent after full meals.

August 6th.—Quantity of urine, 58 ounces; spec. grav., 1,030; 1.8 per cent. of sugar=501 grains. No albumin.

August 9th.—After three days' strict diet, 56 ounces; spec. grav., 1,026; no sugar, no albumin. The patient was in the first stage of diabetes.

At the end of four weeks' treatment she was able to assimilate well from 900 to 1200 grains of amylaceous food.

CASE V.—A., restaurateur, aged thirty-seven, of Berlin, says that he has always been quite well. There have been diabetic symptoms for two years, and the disease was diagnosed about eighteen months ago. Since then he has taken chiefly nitrogenous food. There is no diabetes in his family, nor insanity. He has not been subject to neurotic influences. He ascribes his illness to excesses in sexual indulgence, in drinking, and in smoking.

July 2d, 1884.—He complains of dryness in the mouth, of a disagreeable taste, which occurs apparently without any particular cause, of congestion of head and face, which is sometimes so bad that while walking in the street he has to take hold of something to prevent himself from falling. Complexion ruddy. Breath smells of acetone. Most teeth decayed. There is a slight tremor in the upper extremities, probably owing to excessive smoking. The patient is a powerful man, with strong bones and well-developed muscles and adipose tissue. Liver enlarged, about 0.7 of an inch beyond the ribs. Lungs normal.

Pulse 70, vigorous, full, somewhat increased tension. Apex-beat wide, not easily compressed, in sixth intercostal space, about 0.39 of an inch outside the mamillary line. Dullness in left side everywhere increased. Impulse diffuse and intense; heart's sounds loud and pure.

July 4th, 1884.—Quantity of urine, 61 ounces; spec. grav., 1,027; 2 per cent. of sugar=585 grains. No albumin.

July 7th.—Quantity, 56 ounces; spec. grav., 1,025. No sugar or albumin.

He was in the first stage of diabetes. His tolerance for hydrocarbons was, at the end of four weeks' treatment, fair. He was able to completely assimilate 1200 grains of amylaceous food per diem.

CASE VI.—Mrs. C. A., aged thirty-nine, from London. Has suffered for many years from frequent attacks of muscular rheumatism and headache. Although living in very comfortable circumstances has had much worry and annoyance. To this she attributes the diabetes; no other cause can be ascertained. Her temper is at present very uncertain. Diabetes was diagnosed fifteen months ago.

July 30th, 1884.—The patient complains of increased thirst and frequent calls to pass her water. Fatigue is easily induced, and occipital headache frequent. Independently of the latter, she has also occasionally attacks of megrim. No dyspepsia or constipation; sleep deficient. Painful sense of dragging in legs, which is increased by walking.

She is tall and well made, muscles well, and adipose tissue rather abundantly developed. Complexion fair, but is much reddened by the least excitement.

Pulse full and strong, of medium tension, 68 per minute. The volume of the left ventricle does not appear to be altered. Apex-beat in fifth intercostal space, scarcely extending beyond the mamillary line; nevertheless the elevation appears to be unduly strong to the hand. The dullness is not increased; the sounds are pure and loud. Liver, spleen, and lungs normal.

August 2d.—Quantity of urine, 67 ounces; spec. grav., 1,030; 2.9 per cent. of sugar=936 grains. No albumin, no acetone.

August 5th.—After three days' animal diet the quantity has gone down to 58 ounces; spec. grav. to 1,029; 0.3 per cent. of sugar=84 grains.

In the further course of the treatment, which was carried out for five weeks, the sugar soon disappeared from the urine. The first stage of the disease was evidently not far advanced. The concomitant symptoms, more especially the muscular pains, and sleep, were better.

Three years afterwards I saw the patient again at Carlsbad, on August 3d, 1887. She had changed very little in her appearance. Her general health had been good, with the exception of tendency to congestion of the head. She has more mental force, but some subjective symptoms have supervened which are referable to the heart.

After mental emotions and the use of alcoholic stimulants she complains of severe throbbing in the region of the heart and in the neck. She is unable to take as good a late dinner as formerly, for if she does so, pain in the stomach and shortness of breath come on, and she has a bad night.

The muscles are well nourished. Pulse strong, full, of somewhat increased tension and normal rhythm, 70 per minute.

Apex-beat and impulse much increased. The former is about 0.39 of an inch outside of the left mamillary line, in the sixth intercostal space; it is broad. Dullness at left side transversely as well as longitudinally increased, dullness on right side normal, heart's sounds loud and pure.

The liver projects about 0.7 of an inch below the right hypochondrium, its consistence is normal. Lungs healthy.

August 6th, 1887.—Quantity of urine, 67 ounces; spec. grav., 1,036; 3.5 per cent. of sugar. No albumin.

The sugar disappears after five days' anti-diabetic regimen. The first stage of the disease seems therefore rather further advanced than before.

Case VII.—A. F., aged forty-two, country gentleman, from Pomerania. During the last twelve months marked polydipsia and polyuria; sleep broken. Diabetes was diagnosed eight months ago. Father died of pleurisy, mother still alive at sixty-five. Brothers and sisters are healthy. In June, 1878, had a fall from a horse, and had to remain in bed for some days afterwards. Has committed no excesses, and not suffered from worry or excitement. Has lost 2⅜ pounds of his body-weight of 161 pounds during the last two months.

May 27th, 1886.—Complains of dryness in mouth and increased thirst, undue excitability, and painful dragging in the legs. Sometimes headache and anxious feelings. Virile power normal, digestion good, vision impaired, teeth decayed, breath smells of acetone.

Pulse 65, full, strong, regular, of normal tension. Dullness on left side increased, extending from third to sixth rib, and going beyond the mamillary line. Apex-beat in sixth intercostal space, about 0.7 of an inch outside of the mamillary line; intense and broad. Impulse vigorous, sounds pure, lungs normal. Liver and spleen healthy.

May 30th.—Quantity of urine, 71 ounces; spec. grav., 1,039; 4.8 per cent. of sugar=1635 grains. No albumin.

June 2d.—After three days' rigid diet, quantity reduced to 64 ounces; spec. grav., 1,037; 3.5 per cent. of sugar=1000 grains. No albumin.

Further observation showed that the elimination of sugar could be reduced with nitrogenous diet, but much more slowly than is generally the case in the first stage. In many cases it does not seem expedient to insist on a long continuance of strictly nitrogenous diet, and I did not recommend it in this instance. I could therefore not ascertain whether the sugar might have been made to eventually disappear altogether with such a regimen. The patient was allowed to take 1500 grains of bread and a pint of milk per diem, with sufficient meat and fat; very little alcohol. The mineral water was drunk at a temperature of 71° F.

Towards the end of the treatment the daily quantity of urine varied from 56 to 62 ounces, and that of sugar from 2 to 2.8 per cent.

Case VIII.—Mrs. K., aged forty-four, from St. Petersburg. Has had four confinements; one child died when quite young, of cholera, three others are healthy. Has always had much mental work to do, with sedentary habits. Both parents alive, father seventy-three, mother sixty-six. Has never been seriously ill. Two years ago increased thirst and frequent calls to pass water; emaciation during the last twelve months. Loss in ten months, 11 pounds of a body-weight of 128. Diabetes was diagnosed in September, 1885.

June 7th, 1886.—She complains of occasional faint feelings, tinnitus aurium, strong throbbing of the carotids, and congestion about heart when excited. Short stature, muscles feeble. Adipose tissue slight. Complexion very red, in strong contrast to generally feeble appearance. Eyes rather staring, smell of acetone in breath.

Pulse 64, full, strong, of regular rhythm. Tension somewhat increased.

The physical examination of the heart shows a powerful heaving impulse, extending over several intercostal spaces.

The apex-beat, which is intense, is in the sixth intercostal space, and extends beyond the mamillary line to the left, by about 0.39 of an inch. The left dullness is enlarged in all directions; to the right, dullness not increased. Sounds loud, the first long and muffled.

Urine during night from June 7th to 8th, 28 ounces; spec. grav., 1,035; 2.5 per cent. of sugar=337 grains.

June 15th.—Quantity for twenty-four hours 54 ounces; spec. grav., 1,030; 1.75 per cent. of sugar=465 grains.

June 20th.—Quantity for twenty-four hours, 58 ounces; spec. grav., 1,025; 0.3 per cent. of sugar=84 grains. No albumin.

Further observation showed that patient was in an advanced period of the first stage of diabetes.

Case IX.—S. N., aged forty-eight, a merchant, from Hanover; diabetes diagnosed three years ago. It appears that the disease has become very gradually developed; and as the patient has lived carefully, it has retained the same slight degree of intensity until now. No cause to be ascertained. He complains of nothing but shortness of breath and slight palpitations after fatiguing exercise.

June 1st, 1887.—A tall, vigorous man, muscles and adipose tissue well developed. Florid complexion; teeth good. No smell of acetone in breath.

Pulse 66, full, strong, regular, tension normal. Apex-beat heaving, most intense in fifth intercostal space, still plainly perceptible in the sixth, extends beyond the mamillary line to the left by 0.6 of an inch. Left dullness marked, and enlarged upwards and downwards. Right dullness does not go beyond the right parasternal line. Liver and spleen moderately enlarged; the latter has a tough feel.

June 3d.—Quantity of urine in twenty-four hours, 52 ounces spec. grav., 1,028; 1.7 per cent. of sugar=420 grains. No albumin.

June 5th.—After two days' rigid diet, 53 ounces; spec. grav., 1,023. No sugar or albumin.

A case of slowly progressing diabetes of the first degree.

Case X.—V. W., aged forty; landed proprietor, from St. Petersburg. Has come to Carlsbad on account of liver and stomach trouble. Diabetes has not been diagnosed, although he states that he has for a long time past drunk a good deal of fluid during the night.

August 19th, 1886.—Quantity of urine in twenty-four hours, 65 ounces; spec. grav., 1,039; 3.5 per cent. of sugar. No albumin or acetone.

Patient has been a free liver, smokes excessively, and has a very exciting and fatiguing occupation. An elder brother suffers from diabetes, which has also occurred in other members of his family. His father may possibly have died of it.

A tall, powerful man, muscles good, adipose tissue moderate, complexion normal, ruddy. Expression intelligent, but anxious; conjunctivæ somewhat congested. He is occasionally desponding; has frequent headache, shortness of breath after meals, palpitations on going upstairs, and after much exercise on level ground. No marked cases of cardiac asthma have occurred, but it is evident that there is sometimes failure of the heart's power. He is then suddenly taken with dyspnœa, is obliged to stand still, and afterwards has to go on at a moderate pace. Periodically a dry cough; skin vulnerable.

Pulse 75; radial artery somewhat narrow, low tension; there is an intermittence after every eight to ten beats.

On palpation only a slight vibration is perceived in the heart's region. Apex-beat easily compressible, but plainly perceptible; is in fifth intercostal space, 0.39 of an inch outside of the left mamillary line.

Dullness extends on the left margin of the sternum from third to sixth rib, and is of medium intensity. Heart's sounds plainly perceptible, although somewhat feeble, and not quite regular.

In the lungs a few moist sounds; liver moderately enlarged. Knee-jerk sluggish; vision impaired.

August 22d.—After three days' rigid nitrogenous diet, the sugar disappeared from the urine, but returned on allowing him 1800 grains of hydrocarbons per diem during the next five days, 480 grains being the average. When only 900 grains of hydrocarbons were allowed, there was more tolerance; for at the end of four weeks the percentage of sugar was 0.4, and the quantity 120 grains per diem.

On summing up the results obtained, it is seen that in Case I. hypertrophy of the left ventricle became developed under the influence of the diabetic metabolism, that compensation had been insufficient, and dilatation had ensued. In Case III. it would appear that either previous to the occurrence of the dilatation there had been hypertrophy of the left ventricle (and this is rendered probable by the statements of the patient), or, that it has been produced directly, analogous to that form of dilatation which occurs from over-exertion of the heart (Joh. Seitz, Leyden, Da Costa, O. Fräntzel) by compensatory hyperactivity, and proportionately insufficient nutrition.

Case X. may be similarly interpreted. In this patient, diabetes had unquestionably existed for years before I had the opportunity of diagnosing it. This is rendered evident by the symptoms observed by the patient himself, as well as by the hereditary predisposition which exists, and the numerous

unfavorable influences which have permanently acted upon him.

While the signs of disturbed compensation are in him most prominent, their presence may be understood by assuming that preceding symptoms of cardiac hypertrophy have remained as unnoticed as the diabetes itself. This supposition is all the more probable because the muscular fibres of the heart are as yet in a comparatively good condition; and in consonance with this, the subjective troubles do not show an advanced degree of cardiac insufficiency.

In the other seven cases, the symptoms are so clear that a further argument concerning them does not seem to me necessary.

From the preceding remarks it appears that in a considerable number of cases of diabetes, hypertrophy and dilatation of the heart become developed, without there being any morbid changes in other organs, such as the kidneys, arteries, etc., which so frequently lead to these affections. If we now come to consider to which noxious influences these morbid changes in the structure of the heart are due, it seems most plausible to assume that they are owing to chemical irritation of the heart, by certain matters circulating in the blood; and these matters can only be sugar and urea.

With regard to urea, it has been shown by the experiments of Haughton, Reich, Rosenstein, Huppert, and Gaetgens, that diabetic patients eliminate more urea, other things being equal, than healthy persons. Cases are on record where from three to five times the average normal quantity of urea has been excreted. Thus Dickinson found it in one case to amount to 2130 grains, Leube to 2250 grains, Fürbringer to 2445 grains, and Senator to 1050 grains in a child. I have not unfrequently found it to amount to from 750 to 1200 grains.

It is well known that the quantity of sugar contained in the blood in diabetes far exceeds that which is found in the normal blood, the latter varying from 0.05 to 0.20 per cent.; and although the numbers found by Hoppe-Seyler [19] and Cantari [20] in some cases, *viz.*, 0.9 and 0.8 per cent., cannot be looked upon as averages; yet the blood of the diabetic is always so overcharged with sugar that this latter may act as an irritant upon the heart's substance.

I look upon the anatomical lesions of the heart in diabetes,

which I have described, as consequences of glycæmia and azotæmia.

Such abnormal states of the blood lead to polyuria, glycosuria, and azoturia, which are known to have a prejudicial influence upon the kidneys. If we therefore ascribe the hypertrophy and hyperplasia, which are so frequently discovered in the kidneys of the diabetic, to the presence of the anomalous secretions just alluded to, we may then likewise assume that urea and sugar have the same noxious effect on the heart, in producing an increase of volume in that organ.

In connection with this I may here refer to the experiments of Grawitz and Israel,[21] who produced hypertrophy of the heart in rabbits, first by causing chronic nephritis, and second by removing one kidney. These observers explain the increased cardiac function which took place in their experiments, by the partial loss of renal function; and conclude that those matters which are excreted from the blood by the kidneys constitute an irritant for the heart, leading to increased function and eventually to increased volume.

Riegel,[22] proceeding more from a purely clinical point of view, has furnished another link in this chain of reasoning by showing that in a large number of cases of scarlatinal nephritis increased tension of the arterial system and cardiac hypertrophy ensued, and he has referred this to the retention of urea and other matters in the blood.

I therefore consider that the forms of heart disease which occur in diabetes are owing to the circumstance that the kidneys are unable, after a time, to continue the excessive efforts which they have been called upon to make; that their compensating functional activity gradually decreases, and that this leads to increased cardiac action, hypertrophy and dilatation.

Israel[23] has in another series of experiments varied the conditions under which he had worked with Grawitz, and has arrived at results which afford a considerable amount of support for the views I have been led to form with regard to heart affections being the sequelæ of diabetes. Israel's experiments on rabbits, into the details of which I cannot in this place enter, tend to show that the heart's action may adapt itself from time to time to the way in which urinary matters are formed in the system, and thus conduce to their elimination. He has,

indeed, experimentally proved that we may cause hypertrophy of the heart in animals by the introduction of matters which can no longer be utilized for metabolism, and which must therefore be eliminated.

The disturbance caused by increased elimination of urea was investigated by feeding rabbits with large doses of that substance. They at first received two grammes of it per diem, and the dose was gradually increased to 120 and 180 grains per day, without causing any serious deviation from health in the animals. In all the rabbits which had been thus treated there ensued hypertrophy of the heart within a few weeks. Israel also found that hypertrophy of the kidney preceded that of the heart in all cases, being slight in old animals, and more fully developed in the young; thus showing that the system gradually gets accustomed to increased claims upon the functional activity of the organs. A similar result occurred after the introduction of nitrate of sodium, while grape sugar did not appear suitable for prolonged administration. When, however, injections of a concentrated solution of one or two grammes of this substance were made, either into the veins or the peritoneum, he was able to show by means of the kymographion that an increase in the pressure of blood was the result.

From these experiments Israel has drawn the conclusion that healthy kidneys will to a very great extent answer the increased calls made on their power, but that in extreme cases, such as diabetes and feeding with urea, they eventually become insufficient, and this sooner or later according to individual circumstances. This insufficiency is then met by increased functional activity of the heart, which, if persisting for a sufficient time, leads to hypertrophy of that organ.

It is in this sense that I wish to be understood to account for the hypertrophy and dilatation of the heart, which are so frequently found in diabetes.

It is well known that the kidneys are often found after death in a state of hypertrophy and hyperplasia; and although the results of autopsies of such cases hitherto recorded do not seem to confirm my theory that the heart's volume is eventually increased under these circumstances, I would point to the fact that these post-mortem examinations have been made exclusively on hospital patients, who are generally admitted

for more or less acute diabetes, where rapid wasting of the substance of the organs is so apt to occur.

The cardiac muscle behaves in such cases much the same as other muscles, which, although they have more work to do, yet do not become hypertrophied if they are insufficiently nourished.

A very telling analogous instance is furnished by pernicious anæmia, where the small quantity of oxidizable constituents of the blood, and the necessity of supplying the system with oxygen, may be supposed to act as irritants on the heart, and would lead to hypertrophy provided that organ were well nourished; but as such is not the case, and the heart is yet called upon for undue efforts, fatty degeneration will, on the contrary, be the result.

We may take it for granted that the anatomical lesions to be found in diabetic patients of a better class would differ, as far as the heart is concerned, from those to be met with in average hospital patients.

While regretting the fact that no post-mortem records of the better class of diabetic patients are as yet available, I considered it all the more important to go carefully through the records of the Pathological Institute of Berlin, especially as Israel had already found in 10 per cent. of diabetic cases which had proved fatal in the Charité, hypertrophy of the heart without valvular disease, and without affections of the arteries and kidneys.

Professor Virchow was kind enough to allow me to peruse these records from 1856 to 1887, and in going through them I gave special attention to the facts recorded on the condition of the heart, blood-vessels, and kidneys.

There were altogether 69 cases with the diagnosis of "Diabetes Mellitus." Many of these have already been mentioned in Frerich's book on Diabetes.

In nine out of these 69 cases the heart was found to have been hypertrophied. The records are as follows:—

CASE I.—Auguste Mittelhaus, aged seventeen, laboring woman, died of diabetic coma. At the autopsy the following changes were found: The heart was above the average size, its cavities were enlarged, the endocardium and valves being intact. The whole organ was dilated. The aorta was of medium width (2.3 inches) and it was not diseased. The spleen

was flabby and anæmic, weighing 1500 grains. The liver weighed 2 pounds, 11 ounces, and the pancreas 750 grains. The kidneys were hypertrophied, the right especially; the cortical substance was everywhere broad; the tracings of the blood-vessels on the surface showed unusual size of the several compartments of the cortex. The cortex was proportionately large to the medullary cones. The glomeruli were prominent. The brain was injected; the dura intact; the convolutions were very numerous; the pia had distended veins and was everywhere transparent; the gray matter throughout was everywhere reddened; the cerebral substance was moist and had a peculiarly sweet odor. There were no local lesions.

Case II.—Henrietta Werner, aged fifty-three. In the lungs there existed ulcerous cavities. The heart was somewhat dilated; the muscular fibres were brownish and rather flabby. In the stomach there were evidences of catarrh. The spleen was hyperplastic, as also the kidneys. The skull presented evidences of general hyperostosis. In the brain and cord there existed nothing abnormal.

Case III.—Johanna Born, aged fifty-seven. In the lungs there existed ulcerous cheesy phthisis, cheesy bronchitis and peri-bronchitis. The heart was hypertrophied; the papillary muscle was thick; the ostium of the aorta was wide (2.8 inches); both cavities were dilated. The weight of the heart was 9 ounces, 145 grains. The stomach was dilated and presented evidence of catarrh. The liver weighed 42 ounces, 90 grains. The centres of the acini were hyperæmic. The pancreas was small but normal. The right kidney was of good consistency and weighed 2370 grains, the left weighed 2520 grains. There existed a fibroma of the dura mater.

Case IV.—U., aged twenty-one, female. The heart was strongly developed; both cavities were somewhat dilated. The muscle of the left ventricle was light brown, otherwise intact. The liver was of normal size, the surface smooth. The parenchyma was grayish red except a few yellow spots. The acini were rather small and indistinct. The pancreas was very small, the capsule somewhat adherent with surroundings. Both kidneys were enlarged, the cortex very broad, the design everywhere distinct. There existed hyperæmia of the brain.

Case V.—H. Gaudy, aged thirty-nine. In the thorax there existed: pleurisy; slight broncho-pneumonic foci in left lower border. The heart was large, flabby, with abundant deposit of fat. The stomach was dilated. The liver was small and anæmic; the spleen was rather enlarged. The pancreas was hard and atrophied. The kidneys were hyperplastic. In the brain there existed chronic fibrous arachnitis, œdema of the pia mater, hyperæmia of the medullary substance.

Case VI.—Ramfeld, laborer, aged forty. The heart was

large and flabby; the muscle brownish; the valves normal. The liver was large, dark brownish-red, tough; the acini were indistinctly defined; the cells were turbid, fatty and deprived of pigment; in the left lobe there was a focus of pus the size of a cherry-stone; in the right two smaller ones. The spleen was large and soft. The pancreas was atrophied. The kidneys were moderately enlarged; the left 4¼, 2½, 1¼ inches; the surface was smooth, the capsule was easily removable. Both kidneys contained small abscesses. In the brain there existed purulent meningitis at the base. The posterior cornua of the lateral ventricles, as well as the fourth, contained a turbid yellow liquid. The ependyma was much thickened. The spinal pia mater was purulently infiltrated in the posterior and inferior parts.

CASE VII.—Fromholtz, aged fifty. The lungs were somewhat œdematous, partially adherent; there existed cavernous caseous pneumonia. The heart was somewhat enlarged, the ventricles somewhat dilated, the muscles well nourished. The liver was large and heavy, of reddish-brown color; the acini were small. The spleen was somewhat atrophied. The pancreas was atrophied. The kidneys were enlarged, the surface smooth, the glomeruli strongly filled. The dura mater was thick; the veins greatly distended; the sinuses were all wide, filled with blood and tough fibrinous clots. The pia at the cortex was turbid, and œdematous. The posterior cornuæ were adherent. The white matter of the brain was moderately hyperæmic. The cortex was small and pale. The posterior choroidal plexus was very strongly developed. The floor of the fourth ventricle was very tough and smooth. The striæ acust. on right side were powerfully, on the left side hardly, developed.

CASE VIII.—Carl Schmidt, aged fifty-seven. In the lungs there was ulcerous, cavernous phthisis. The heart was rather large, the muscles pale and rather tough. The mucous membrane of the stomach was reddened and presented evidence of gastric catarrh. The liver was large (nutmeg); it weighed 48 ounces, 89 grains. The spleen was enlarged, weighing 13 ounces and 53 grains. The left kidney was much enlarged. It weighed about 7 ounces. Its dimensions were 5, 2½, 1⅜ inches. The capsule was thin, easily removable, the surface smooth, the glomeruli large. The dimensions of the right kidney were 4¾, 2¼, 1¼ inches. The splanchnic nerves on both sides were rather strongly marked. The sympathetic in the abdominal cavity on both sides was very feeble. The skull was extremely thick with hardly any diploë. The dura was thick; the root of the pneumogastric was rather small; the sinus transversus was wide. The brain weighed 48 ounces, 19 grains. The gray matter was rather pale; the fourth ventricle rather small; the ependyma in its lateral parts granular.

CASE IX.—Otto Gaehne, workman, aged twenty-six. In the lungs there existed ulcerous, cavernous phthisis, principally in the right; embolism and thrombosis of the pulmonary arteries; hemorrhagic infarctus of the inferior lobes of both lungs; catarrhal pneumonia with multiple cheesy foci; cheesy bronchitis and peri-bronchitis; fibrinous and tubercular pleurisy. The left ventricle of the heart was dilated and partially filled with a thrombus. The aorta was narrow. The heart showed globular rounding off at the apex. The substance of the ventricles was of good consistence. The valves were intact. There were present in the digestive organs evidence of catarrhal gastro-enteritis. There was red atrophy of the liver; and sclerotic hyperplasia of the spleen. The dimensions of the left kidney were 4.8, 1.2, 8.6 inches; it was normal; the right kidney was pretty much the same.

The percentage in these records of hypertrophy or dilatation of the heart is 13.0, while in the cases observed by myself it amounted to 21.6 (82 out of 380).

If we now consider that most of the post-mortem records just given show simultaneous severe affections of the lungs, and nearly all of them morbid changes in the brain, while in my own 82 cases no organic disease could be discovered either by clinical symptoms or physical examination, the percentage of 13.0 must be looked upon as considerable. I will not omit to mention that in a number of the other post-mortem records hypertrophy of the heart with chronic endo-aortitis as well as endo-arteritis and hypertrophy were the primary affections.

While, therefore, heart disease in diabetes has only quite recently been mentioned by a very few authors, the occurrence of arterio-sclerosis in that disease has been much more fully dwelt upon, more especially by Frerichs. Those who leave out of account the increased functional activity of the heart have to look to the chemical alteration of the blood as the cause of the vascular disease.

We have seen above that the accumulation of sugar and urea in the blood is not proportionate to the quantity of these substances which is eliminated, but that, on the contrary, in consequence of increased cardiac activity, a compensatory elimination takes place in the urine, which is partly owing to enlarged kidneys and partly to changes in the heart's structure. The dilatation of the blood-vessels, which occurs subsequently, is simply owing to the increased work of the heart, which throws more blood into the vascular system in a unit

of time. Vascular disease is the consequence of permanent mechanical irritation.

Sir William Gull's and Dr. Sutton's "Arterio-capillary fibrosis," as occurring in nephritis, and Ewald's "Muscular hypertrophy of the arterioles,"[24] must be looked upon as a secondary consequence of the cardiac disease. In the same way the occurrence of arterio-sclerosis in diabetes has to be traced to the mechanical influence of cardiac changes.

To a certain extent, Leyden has taken the same view of these matters in his paper "On heart disease in consequence of over-work," p. 7, where he says, "Although the connection of arterio-sclerosis with physical efforts cannot be made out with absolute certainty, yet it is rendered highly probable by the fact that the working classes suffer from it more frequently, and at an earlier age, than the middle and upper classes; and males more frequently than females."

I hope to have rendered it evident that the cases of cardiac disease which I have observed in patients suffering from diabetes, have to be traced to morbid changes of metabolism. My argument is moreover well supported by the observations of several authors, such as R. Schmitz, who have apparently found fatty degeneration of the heart in a large percentage of cases of diabetes.

If we read such statements by the side of the anatomical records which I have given, it will be seen that they will have to be taken for what they are worth; for neither fatty metamorphosis nor infiltration of fat have been at all commonly met with post-mortem. On the other hand, such observations have a clinical value; since, as far as symptoms are concerned, fatty degeneration, infiltration of fat, brown atrophy, dilatation, and other anatomical lesions of the heart, may show at times the same clinical aspect, *viz.*, of cardiac asthenia; which latter appears to me due to the claims made upon the heart by the diabetic change of metabolism. Compensation under these circumstances must always be temporary, more especially where the nutrition of the system in general suffers at an early period, and where the formation of urea and sugar exceeds that limit within which well-nourished kidneys and a well-nourished heart are able to eliminate these substances.

As far as treatment is concerned, it appears from the foregoing that everything should be avoided which may impair

the action of the heart and kidneys; for we know that organs which are in a state of hyper-activity easily become diseased. I may here refer to the frequent occurrence of valvular disease in nephritis, and of nephritis in diabetes. The latter I have found recorded in 30 out of 66 cases contained in the records of the Pathological Institute of Berlin. Stokvis[25] has forcibly drawn attention to the same point in his able paper on diabetes read before the late Medical Congress at Wiesbaden; while I have seen nephritis in 64 out of 380 cases, although not frequently in the form of contracted granular kidney.

The principle of sparing the suffering organs as much as possible, has, in my opinion, to be carried out, particularly as regards diet. In many cases a rigid nitrogenous diet cannot be enforced. I have on this account, during the last few years, frequently added milk to the diabetic diet; and am able fully to corroborate the favorable testimony which Hoffmann has given on this point, before the late Medical Congress.

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BLENORRHOEA

OF

THE SEXUAL ORGANS

AND ITS COMPLICATIONS.

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BLENORRHŒA OF THE SEXUAL ORGANS.

HISTORY.

ALTHOUGH the views concerning the antiquity, development and origin of constitutional syphilis are very divergent, and the documents and data which testify to the knowledge of this plague in the time of the Jews, Romans and Greeks are so scanty and obscure, that we must strongly doubt whether this mooted question will ever be definitely settled, nevertheless we may maintain with positiveness that blenorrhoic disease of the genitalia are as old as the human race. At all events they can be traced back historically almost as far as the history of man, and appear at the same time as the latter out of the mythical obscurity of legends and tradition. We find at least, among the cultivated nations of antiquity as well as of the Middle Ages, in part appropriate descriptions of the symptoms of blenorrhagic affections, in part unmistakeable indications that the etiology, the contagious character of the disease, had not escaped observation. This original clearness and correct knowledge gave way to confusion when, almost coincidently with the discovery of America, syphilis traversed Europe as a pandemic,—whether as a new disease may be doubted, but at all events with hitherto unknown virulence. The relatively mild and harmless symptoms of blenorrhœa were of no importance compared with the severe manifestations of syphilis, the majority of which also started from the sexual organs, and thus blenorrhœa sank into oblivion, at least among medical writers. And as in the same measure that the violence and malignancy of syphilis gradually diminished,

blenorrhœa again became the subject of observation and study; the knowledge that both diseases were localized generally in the genitalia, often occurred together and were both contagious, led to their being grouped together, and to blenorrhœa being regarded as a symptom of syphilis. Although this view did not remain unopposed, it prevailed for a long time, and not until the middle of the eighteenth century did the number of voices which advocated the separation of blenorrhœa from syphilis become greater and their importance more and more considerable. Finally, the separation became definitive in the thirties of the present century.

Thus we can distinguish three periods in the interesting history of blenorrhœa, the first period—until the occurrence of syphilis—in which blenorrhœa stood alone; the second—until 1830—which represents the period of confusion; the third period, beginning with 1830, and which continues to the present time.

First Period: until the occurrence of Syphilis as a Pandemic.—Numerous texts prove that blenorrhœa was known to the civilized nations of antiquity, and that it was also regarded by them as contagious.

Thus the Jews knew blenorrhœa very accurately, and in Leviticus iii. 15, Moses not alone gives a description, but also sanitary and police regulations which testify to accurate knowledge of the disease.

Whether the words used concerning David's disease in Lev., Chap. xv., refer to this affection must remain in doubt.

Maimonides describes blenorrhœa clearly. He says: the fluid escapes without erection and without a feeling of pleasure; the appearance is similar to that of barley dough in water, which is dissolved, or coagulated albumen, and is the result of the internal disease; it is also essentially different from the seminal fluid and mucus, the latter being more homogeneous. Maimonides mentions seven causes of the disease, including amorousness and excesses.

Blenorrhœa was also well known to the Greeks and Romans. Thus, Herodotus relates that the Scythians, who had violated the shrine of Venus-Urania, were attacked by the morbus femineus of the νοῦσος θήλεια. Hippocrates speaks of the sensation of burning during micturition and of the white discharge of women. Celsus mentions ulcers in the urethra and the dis-

charge of bloody, purulent matter from the canal. Corresponding texts are found in Juvenal, Martial, Dioscorides, Scribonius, Largus, Sextus Placidus, Pliny and Galen. Galen, in particular, separates satyriasis, the escape of semen from the erect penis, from gonorrhœa, the escape of semen without erection. Aretæus distinguishes vaginal blenorrhœa from fluor, and Marcellus Empyricus, Physician to the Emperor Theodosius, mentions remedies.

The statements of writers of the Middle Ages concerning blenorrhœa are more numerous and detailed, above all those of the Arabists. Thus, we read in Johannes Mesue, who lived in the tenth or eleventh century: *Si vero in via et ductus urinæ ulcera sunt, cognoscuntur ex dolore magis in urinæ egressione et sanie egrediente ante urinam. Ulcera virgæ et apostemata sunt proportionalia ulceribus et apostemalibus testium.* Haly Abbas speaks of an urethritis which is accompanied by a white discharge and pain in urination. Rhages discusses burning during micturition. He recommends bolus armena, dragon's blood and injections in purulent discharges from the urethra. Serapion also discusses blenorrhœa, ulcers in the urethra, which provoke pain and purulent discharge. He defines gonorrhœa as increased involuntary discharge of semen and recommends hemp seeds against it. He also gives a good description of the suppurations of the female genitalia, which result from excessive coitus. Ebu Sina describes clap as follows: *Sentitur acuitus et mordicatio in egressione et quandoque est cum eo ardor urinæ, et est color ejus ad citrinitatem declinis.* In the eleventh century Abulcasem used injections of a mixture of vinegar and water in gonorrhœa.

In the other writers of the Middle Ages we also find descriptions of blenorrhœa, as well as some police ordinances for the prevention of its spread by prostitutes. Gariopontus discusses gonorrhœa, and Michael Scotus, physician to the Emperor Frederick I., recognizes its infectious nature. Rogerius, a physician of the twelfth century, treats of *reumatisatio virgæ: Quando reumatisant humores ad canales virgæ, et faciunt ibi pustulas et apostemata, si fiat de calida causa, cognoscitur per calorem, per functionem et arsenas per ruborem et inflammationem membri, si fiat de causa frigida, cognoscitur per remotionem punctionum, et mordicationem et per exclusionem ruboris; in utraque*

causa difficultas mingendi. Lanfrancus, a pupil of William de Saliceto and a distinguished physician of the 13th century, speaks *de apostematibus virgæ* in the following terms: *Aliquando repletur virga ventositate grossa, ipsam cum dolore minis extendente, cum autem cessat materiæ cursus, si vero apostema testiculi induretur.* Constantinus Africanus recommends remedies against strangury. Joannes Ardern, a physician of the 14th century, recommends sedative injections against blenorrhœa. Guido de Cauliaco speaks, in his Surgery of burning and disease of the penis from intercourse with a diseased woman. Joannes de Gaddesden recognized urethritis and epididymitis, he was also acquainted with vaginitis. Similar statements are found in Valescus de Taranta, Gulielmus Varèguana, Magninus, Joannes Arculanus, Joannes de Tornamira, Antonio Cermisone and many others, which leave no doubt that blenorrhœa was very well known, was regarded as contagious, and treated with local remedies. That the contagious character of blenorrhœa was generally recognized is shown above all by some police ordinances which have come down to us. Thus, Beckett reports an ordinance of the Bishop of Winchester for the houses of prostitution of Southwark, a suburb of London, which, eighteen in number, are said to have been under the supervision of this Bishop. This ordinance dates back to the year 1162. One of its articles reads as follows: *De his qui custodiant mulieres habentes nefandam infirmatatem,* and begins thus: "That no Stewholder keep noo woman wythin his hous, that hath any sycknesse of Brenning," or, as is said in a similar ordinance of this Bishop, "the perilous infirmity of burning."

An ordinance concerning the establishment of a house of prostitution in Avignon, which is attributed to Johanna I., Queen of both Sicilies, is dated August 8th, 1347. The fourth article of this ordinance reads: "The Queen commands that the superintendent and a surgeon appointed by the authorities examine, every Saturday, all the whores in the house of prostitution. And if one is found, who has contracted a disease from coitus, she shall be separated from the rest and live apart, in order that she may not distribute her favors, and may thus be prevented from conveying disease to the youth."

All these quotations show sufficiently that blenorrhœa existed in antiquity and the Middle Ages, that its nature and

contagious character were recognized, and that prophylactic and therapeutic measures against it were adopted. Then towards the end of the 15th century syphilis appeared upon the scene, and spread rapidly with hitherto unobserved intensity. What wonder that the attention of the medical public was directed exclusively to the new and malignant disease, that blenorrhœa sank into comparative oblivion and that thus begins

The Second Period, that of Confusion.—It would be going too far to assume that the newly developed syphilis had cast gonorrhœa into complete oblivion. This is not true. It was merely that the new and interesting disease diverted attention and study from the old and known, but without causing it to be forgotten. Thus, the contemporaries of the first great epidemic of syphilis speak incidentally of blenorrhœa as a disease long known, or they do not mention it at all in the treatises devoted to the new affection. Thus, Grunpeck (1496), Fracastor (1530), Mattheoli (1536), Massa (1536), do not mention gonorrhœa; Johannes de Vigo (1513) in his Surgery, in the chapter *de auxiliis ægritudinum virgæ*—speaks in detail of blenorrhœa and its treatment. Alexander Benedictus (1510) discusses syphilis and clap separately, as does Marcellus Cumanus, a military surgeon of the Venetian Army during the period of the first epidemic (1495). Jaques de Bethencourt (1527) relates the history of a chronic blenorrhœa. Paracelsus (1530) also recognized blenorrhœa, and mentions it as a possible complication of syphilis, like dropsy, podagra, paralysis, icterus and catarrh. In England Simon Fish (1530), Andrew Boord (1546), Michael Wood and William Bulleyn (1560) describe blenorrhœa, particularly in women, as a distinct disease, separate from syphilis. It seems to have been very widespread among prostitutes.

In opposition to these views Musa Brassavolus (1553) appears to have been the first to regard blenorrhœa as a symptom of syphilis, and, like the latter, as a new disease, whose origin dates to the year 1531. Nevertheless Brassavolus did not believe that symptoms of syphilis could develop from gonorrhœa. Gabriel Fallopius, the pupil of Brassavolus, coincides in this opinion of the syphilitic character of gonorrhœa. In a treatise published in 1563 we read: "the final symptom is Gallic gonorrhœa. Thirty years may elapse before this discharge begins." Tomitanus also accedes to the opinion

that blenorrhœa is a symptom of syphilis, and this belief prevailed for nearly two centuries. The results of this view were serious. Every clap was regarded as of equal importance to syphilis, and subjected to the most vigorous treatment with mercury, guaiac and sarsparilla. A few warning voices were raised, for example P. Haschard (1554).

It was not until the beginning of the 18th century that the opposition began, at first timidly, then more boldly, and thus *the third period in the history of blenorrhœa* was inaugurated. Cockburn's (1715) statement that blenorrhœa was not usually followed by symptoms of syphilis, remained unnoticed. This is also true of Boerhaave's (1753) admission: Balfour (1767) asks very timidly: *Nonnie potius suspicandum est, longe diversam esse materiam, quam luem paruit, ab ea, ex qua gonorrhœa efficitur.* Hales (1770) was the first to advocate the complete separation of the gonorrhœa and chancre virus, and Ellis (1771) made a large step in advance by making experiments subservient to his views. He also distinguishes the virus of syphilis from that of blenorrhœa. He says: "It seems most probable that there is something in the venereal particles of matter, in a gonorrhœa, which is very different in its nature and figure from that of the pox. * * * * The virus of the gonorrhœa, if exposed to any part denudated of its skin, will not form a chancre, but will heal with a little styptic wash, and any soft dressing, as I have observed in several cases." Bayford (1773) opposes Ellis' views because he never succeeded, with the aid of the microscope, in detecting any difference between the pus of clap and chancre. Tode (1774) combatted the identity of the virus of clap and syphilis, and likewise Duncan (1777), who adduces as an argument the fact that the inhabitants of Otahiti were acquainted with syphilis long before clap was imported among them. Harrison (1781) and Swediaur (1784), also employed the experimental method, but were led by their investigations to support the unitists of both viruses. And thus the syphilidologists at the end of the 18th century were divided into two camps—the identists who believed in the identity of the virus of clap and syphilis, and their opponents, the dualists. Once again the scale turned in favor of the identists. John Hunter entered the arena. There are few names so popular in our specialty, and when Ricord and Sigmund are mentioned to-day, Hunter

is usually added as the third. Unfortunately with but slight justification. Not that we deny to Hunter ardent, even passionate devotion to his profession, great gifts and scientific earnestness, but it is rare that such qualities have produced poorer fruits, and have done less to forward a science than in the case of Hunter, very much to the disadvantage of the beginning freer development of our specialty. With the object of checking the battle between the identists and non-identists, and of getting at the truth of the matter, Hunter performed (May, 1767) upon himself, it is said, the following inoculation experiment, which proved so momentous to our science. One Friday, as he relates, he inoculated the gonorrhœal pus into the glans and prepuce by means of two incisions with a lancet. Both incisions were converted—that on the prepuce more rapidly, that on the glans more slowly—into pustules and superficial ulcerations, which were accompanied by inflammatory symptoms. Both spots were then cauterized repeatedly and slowly healed. During recovery swelling of the inguinal glands occurred, about three months later an ulcer appeared upon the tonsils, and three months later a copper-colored pustular eruption, *i.e.*, symptoms which could certainly be attributed to syphilis. Despite all previous experience this experiment was sufficient for the investigator, who was very quick in arriving at conclusions, to draw the inference that gonorrhœal pus may produce chancre. This single experiment involved a standstill—yes, a retrogression of more than sixty years—since even the shallowest follower of Hunter felt himself justified, relying upon Hunter's authority, his inoculation experiment and "personal experience," in breaking a lance for the unitist theory. It is true that Hunter distinguished a venereal from a simple clap, which could develop from other causes, or even spontaneously, but he did not clearly describe their differential diagnostic signs. And so began anew the struggle between the unitists and dualists, the former maintaining, through Hunter, the upper hand. Hogan's (1787) opposition to Hunter's doctrines passed unnoticed. If the dualists claimed that constitutional syphilis never develops after clap — that the virus of clap never produces chancre, that of chancre never produces clap—that mercury cures syphilis but not clap—that clap and syphilis developed at entirely different periods—that clap generally

recovers spontaneously, syphilis never without the aid of art, —the answer given by the unitists was always the same. It is true, they said, that syphilis develops after a neglected clap, though not so often as after chancre—it is claimed that chancre virus does not produce clap and *vicè versa,* but experience proves the contrary; that mercury is not necessary to the cure of gonorrhœa is owing to the fact that the clap virus in the urethra is outside of the circulation, and its absorption is made difficult by the increased secretion of mucus; however, many gleets are not curable without mercury. Buboes, like clap, also existed prior to syphilis, and are nevertheless undoubtedly syphilitic in character.

Benjamin Bell (1794) was the first who, based upon a series of experiments, secured a hearing for his opposing views. Starting from the theory of the unitists that the same virus produces ulcers upon the glans penis and clap upon the mucous membrane of the urethra, he raises the following objections: *a.* Chancre should be more common than clap, since the outer surface of the glans is more exposed to infection than the mucous membrane of the urethra. *b.* Chancre should always be complicated with clap and *vicè versa,* since the pus from ulcers of the glans always passes into the urethra, the pus of clap always reaches the glans. *c.* The pus from the urethra is often so acid that it excoriates the glans and prepuce but does not cause ulceration. *d.* Even the smallest chancre produces general infection. *e.* Clap and the erosions of the glans produced thereby do not give rise to syphilis. *f.* Chancre pus placed in wounds produces the venereal disease, the pus of clap does not, as the inoculation of two physicians with gonorrhœal pus showed. It would also be necessary to assume that a person who merely had a chancre conveys clap to another, and *vicè versa.* Clap is a discharge of pus-like material from the urethra, and is a local disease in every case; clap and chancre were present separately in different countries at different times. Mercury, which cures syphilis, is useless in clap.

Clossius (1797) coincided with Bell's opinions, Evans and Le Bon (1789) strengthened them by experiments, but Hernandez (1811) first exercised a decisive influence and became a forerunner of Ricord on account of the large number of his experiments (he inoculated seventeen convicts with gonorrhœal pus, always unsuccessfully).

The dispute concerning the identity of the virus of clap and syphilis led to the adoption of two extreme views. The investigations and experiments of Caron (1811) not alone induced him to deny the identity of the two poisons, but he denied the virulence of clap. Thus, Caron and his adherents, Jourdan (1826), Richond de Brus (1826), Devergie (1836), Desruelles (1826), taught that clap is devoid of any virus, that it is neither a virulent nor a contagious disease, but a simple genuine inflammation. In Germany, on the other hand, the careful study and observation of gonorrhœa and its course had led to its entire separation from syphilis, but its purely local character was also denied. It was regarded as a general disease and spoken of as a "clap diathesis." In the works of the adherents of this view—Autheuriet (1809), Ritter (1819), Eisenmann (1830)—we read not alone of clap but also of various sequelæ or metastases, such as lung clap, ear clap, gonorrhœal meningitis, clap ulcer, clap neuroses, gonorrhœal amaurosis, congenital and acquired clap diathesis.

Upon this confusion entered Ricord. Supported by large experience, critical and brilliant dialectic powers, but unfortunately, at the same time, deaf to all justifiable opposition to views which he had once regarded as correct, Ricord as the result of 667 inoculations, established the doctrine (1831 to 1837) of the non-identity of the virus of clap and syphilis, and advocated it so clearly and pertinaciously that all opposition soon ceased and this view seems settled for all time.

Although this question was settled, there developed with and on account of Ricord a new struggle, the struggle concerning the etiology of clap, and this we will consider in the following section.

Etiology.

Ricord's numerous inoculations and the acute reasoning which accompanied them definitively separated gonorrhœa from syphilis, and although an identist voice was occasionally raised, the theory of the identists like that of Caron and Eisenmann secured no adherents, although some distinguished specialists, like Vidal de Cassis and Simon, still favored it and now and then broke a lance for it. For the great majority gonorrhœa remained permanently separate from syphillis.

But now arose a second important question: If clap is not produced by the syphilitic virus, is it the product of a virus at all, or is it a simple, non-virulent inflammation? In addition to syphilitic clap—produced by the syphilitic virus, and which, in consequence of its development from the syphilitic virus was followed by syphilitic secondary symptoms — the adherents of the unitist theory, Brassavolus, Hunter and many others, had distinguished a simple genuine clap, which was supposed to occur as a simple catarrhal disease from various causes or even spontaneously. Now that the syphilitic clap disappeared, it was natural that the second variety, the simple clap, alone should be supposed to exist.

And this, in fact, was taught by Ricord. He denied the virulence of clap, and regarded it as a simple catarrh which may be due to various irritants. Among these irritants he attached the chief importance to gonorrhœal pus, which reproduced gonorrhœa merely by irritation, not as the result of a virus or contagious principle. But other secretions, menstrual, lochial and puerperal discharges and leucorrhœa, may also act as irritants and produce blenorrhœa. The same effect was said to result from acrid injections, introduction of instruments into the urethra, mechanical irritation, the ingestion of acrid food and drink. Even sexual excesses in perfectly healthy individuals, or mere long protracted sexual excitement and protracted erections without coitus or sexual contact, were said to produce clap. Ricord based these views in part upon previous experience, especially Swediaur's experiments, in part upon confrontations. He laid special stress on the fact that in confrontations in cases in which the male partner had acquired clap, the female was often found entirely healthy or often sufered merely from leucorrhœa, menstruation, etc., and the development of the clap must be attributed to one of the abovementioned causes. Finally, he called attention to acclimatisation, which renders one accustomed to it insensible to such irritation, but affects the new-comer with blenorrhœa. From all these experiences Ricord concluded that blenorrhœa is not a virulent disease, that it may develop without inoculation, that it may be acquired from the most innocent girl, the most virtuous wife. In his easy manner of presenting his views he even went so far as to devise a prescription for the means to be employed for surely acquiring blennorrhœa. I reproduce

it, since it not alone contains the quintessence of his views on this subject, but also furnishes an admirable characteristic of Ricord himself: "Do you wish to contract clap? This is the way. Take a pale, lymphatic woman, blond rather than brunette, and as leucorrhœic as possible. Dine with her; begin with oysters and continue with asparagus, drink a good many dry white wines and champagne, coffee, liqueur. All this is well. Dance after your dinner and make your partner dance. Warm yourself up, and drink a good deal of beer during the evening. When night comes, conduct yourself bravely; two or three acts of intercourse are not too much, more are still better. On waking do not fail to take a long warm bath and to make an injection. If this programme is carried out and you do not get the clap, it is because God protects you."

These statements of Ricord first led to the experimental production of blenorrhœa by the introduction of genuine pus. Thus, in two individuals, Voillemier introduced into the urethra bougies which had been smeared with pus from an abscess of the thigh and neck. The bougies remained in the urethra an hour without producing clap. Other similar experiments proved negative, but the production of clap was always successful when the pus was taken from another clap or from conjunctival blenorrhœa (which was soon recognized as identical), as shown by the experiments of Pauli, Guyomar and Thiry. Not alone was the difference between blenorrhagic and genuine pus determined in this way, but the advocates of the virulent nature of clap, the virulists, raised other objections based upon observation. Thus, it was emphasized that in properly regulated marital life, the development of clap was not observed despite leucorrhœa, menstruation, or even the ichorous discharge of a uterine cancer. This is also true of localities which are shut off from communication with the outside world, and thus prevent little opportunity for the importation of clap, despite vigorous sexual intercourse or even excesses on the part of the inhabitants. Thus Rosolimos relates that the Greek farmers, who are very continent before marriage and are very faithful in marriage but commit the greatest excesses are unacquainted with gonorrhœa. Michaelis reports that the physicians practising in Lippe often did not observe a case of clap for years. Milton states that for several years he was the sole practitioner in a small town, and during

this time treated several cases of clap, all of which proved to be imported, while he did not observe a single case acquired in the town, although there was no lack of opportunity for such acquisition. Further arguments are deduced from the course of blenorrhœa and comparisons with traumatic and chemically-produced urethral catarrhs. Thus, traumatic and chemical catarrhs develope immediately after the noxious action, have no tendency to propagation, but rather a tendency to spontaneous rapid recovery. On the other hand, virulent blenorrhœa has a period of incubation, a tendency to spread over the entire mucous membrane, and if not treated it does not heal spontaneously but passes into a chronic condition. The anti-virulists, who attributed the development of clap directly to the irritant action of the pus corpuscles and regarded the intensity of the action as proportionate to the number of pus corpuscles in the secretion, were told that a minimum amount of mucous secretion, and one very poor in pus corpuscles, from a beginning or a chronic blenorrhœa, would suffice to produce a violent clap.

In this way the struggle lasted for more than forty years, and sides were taken by very prominent writers. Among the anti-virulistswere Acton Hacker, M. Robert, Fournier, Langlebert, Geigel, Mueller, Bumstead, Tarnowsky, Jullien; among the virulists were Baumé, Hoelder, Reder, Milton, Belhomme, Martin, Lebert, Sigmund, Zeissl, Diday. Finally, the latter began to gain ground, the anti-virulistic theory lost more and more supporters. One circumstance contributed materially to this change. A group of investigators were not satisfied with discussing the question of the existence of a virus in an academic manner, but attempted to discover the nature of the virus itself, and to determine its action.

The theory that the virus of syphilis was a virus animatum was held at a remarkably early period of our specialty. Thus, in 1710, we read in a, it is true, very little known author, Deidier: "I believe that the venereal virus consists of nothing else but living maggots, which produce ova by copulation and which readily multiply as do all insects. These being assumed venereal diseases are explained much more readily than by any other hypothesis. . . . These maggots hatch and produce others and in this way we can assume the propagation of the venereal virus. How can it be supposed, as is done,

that pox could be carried from the Orient into Europe, and then pass, by commerce with a single prostitute, into the French army and thus to France, were it not for the venereal maggots which furnish a prodigious number of ova and which always find, in foul semen, the degree of putrefaction requisite to make them hatch?" However *naïve* the conception, the chain of thought is correct, and this man divined what could not be proven until two hundred years later.

The followers of Deidier also adhered to the theory of the *virus animatum*, which they sought to discover. Donné (1837) called attention to the presence of an infusorium, which he called "trichomonas vaginalis," in the pus of blenorrhœa vaginæ, and he concluded from his investigations that: 1. Purulent vaginitis is very often blenorrhagic, and that the purulent discharge ordinarily contains the trichomonas; 2. When it does not result from venereal infection, I am forced to conclude that it does not develop on account of these animalcules. Further investigations showed that the trichomonas was an accidental appearance, which is also present in healthy vaginal secretion. Jousseaume (1862) reports the discovery of an alga, which he called genitalia, in blennorrhagic pus. This discovery also proved illusory. Salisbury (1868) found threads of fungi and spores, which he called crypta gonorrhoica, in blenorrhagic pus; these were said to multiply in epithelium cells and to be found in the epithelium of the orifice of the urethra. Hallier (1868) published a similar discovery of a fungus with schizosporangia, which he called coniothecium; he produced cultures.

Thiry (1849) formulated different views. He investigated the contagious Egyptian eye disease, determined its blenorrhagic character by inoculations, made control inoculations of gonorrhœal pus into the eye, and came to the conclusion that in all these cases there was a contagious disease of the mucous membrane produced by the same virus. In the study of ocular blenorrhœa as distinguished from catarrh, the granulations appeared to him to be the essential characteristic; they were present in all cases of blenorrhœa, absent in all cases of catarrh. Inasmuch as blenorrhœa reproduces blenorrhœa, *i.e.*, granulations reproduce granulations, he defined the former as a specific, contagious process, characterized by the formation of granulations, and he applied the term "virus granuleux" to its contagious principle. There is no blenor-

rhœa without granulations, and hence Thiry demonstrated their presence in the blenorrhagic diseases of the vagina and uterus. Desormeaux (1865) showed their presence in the urethra by examination with the endoscope.

A decided change in this question did not occur until the new etiological impetus of pathological anatomy, which was prepared by Hallier, Pasteur and Klebs, and inaugurated by Koch, began to make its way. In 1879 A. Neisser reported a micrococcus peculiar to gonorrhœa, which he found constantly in the pus of clap and gonorrhœal conjunctivitis by means of Koch's staining methods. In 1880 these statements were confirmed by Bokai and Finkelstein, who not alone corroborated the constancy of occurrence of the gonococci, but also stated that they had cultivated them and had produced acute urethritis in two cases by inoculation of the cultures into the urethra. Further corroborative investigations followed rapidly. Weiss (1880) and Aufrecht (1880) noticed the presence of the gonococci in a large number of urethral blenorrhœas. Haab (1881) found that the cocci of blenorrhœa neonatorum were absolutely identical with gonococci. Hirschberg and Krause (1881) found the cocci in all cases of blenorrhœa neonatorum, but claimed to have demonstrated similar forms in simple catarrhs, and in the vaginal secretion of healthy women. Sattler, Hirschberg and Lebert (1881) agreed with the statements of Neisser. In 1882 Neisser himself published a detailed communication in which he describes the shape of the gonococci and their mode of increase, and also partly successful attempts at culture. Krause (1882) also reported similar results concerning blenorrhœa conjunctivæ. As the result of a large series of investigations Leistikow (1882) came to the conclusion that the microscopical demonstration of gonococci in a secretion proves its blenorrhagic character. Culture experiments which he made with Loeffler, proved unsuccessful. Ecklund (1882) stated that he found the gonococcus in all possible secretions, and therefore denies its specific character. On the other hand he found constantly, in blenorrhœa, a fungus, ediophyton dictyodes, which is also present in the discharges of summer diarrhœa and dysentery and in the urine in scarlatina, and this he claims is the virus of blenorrhœa (!!). In 1883 appeared a noteworthy publication by Bockhart. He first laid stress on the constant finding of gonococci in

258 cases of blenorrhœa, then reports the successful culture and inoculation of the pure culture in the urethra of a paralytic, who suffered in consequence from a subacute urethritis. At the autopsy (the patient died of pneumonia ten days after the inoculation) were found renal abscesses, pyelitis and cystitis, which were infiltrated with masses of cocci. Microscopical examination of the urethral mucous membrane showed inflammatory infiltration, with accumulation of cocci in the lymphatic vessels. Bockhart's results, both as regards the pure culture and inoculation and also the microscopical appearances, were combatted, the former by Loeffler, the latter by Arning. Loeffler denies the genuineness of the gonococcus pure culture, and Arning maintains that the cocci heaps described by Bockhart in the lymphatics were really mast cells. In the same year appeared corroborative articles by Eschbaum, Newberry, Campona, Marchiafava and Keyser. The latter examined 64 cases (30 whites, 34 negroes) of urethral blenorrhœa, and found the gonococcus constantly. They were absent only in two treated cases and in one recent case with scanty secretion. Equally positive results were afforded in three cases of ocular blenorrhœa in adults, and one case of blenorrhœa neonatorum. Numerous control examinations of various kinds of pus always gave negative results. Sternberg (1883), however, denied the specific character of the gonococcus, which he regards as identical with the micrococcus ureæ. In 1884 appeared the article by Zweifel, who showed that only gonococci-containing, but never gonococci-free, lochial secretion is able to produce blenorrhœa neonatorum. Bumm isolated a series of other diplococci found in the vaginal secretions, and studied their morphological characters and virulence by means of cultures and inoculations. He also claims to have found gonococci constantly in those lochial secretions which had given rise to blenorrhœa neonatorum. Welander reports similar results. In 25 confrontations, which he undertook, he found gonococci in both partners; inoculation of vaginal secretion, which was free from gonococci, into the male urethra always gave negative results, while he obtained typical positive results in three cases when small amounts of gonococci-containing pus were placed in the male urethra. Further positive results were obtained by Chameron, Wyssokowitch and Belleli, the latter making his investigations in an examination bureau for prostitutes.

Aubert found the gonococcus in more than 200 cases of blenorrhœa and he regards it as the most frequent cause of clap. But in a few cases of urethritis, which were followed by epididymitis and cystitis, he found no gonococci, but always the same variety of bacteria, so that, in addition to the most virulent and frequent blenorrhœa-producer, the gonococcus, he distinguishes other, less frequent, virulent micro-organisms. In 1884 Sternberg published a paper for the opposition, in which he denied the specific character of the gonococcus on account of the negative results of very questionable pure cultures. Gama Pinto found gonococci in all kinds of pus, so that he does not regard them as specific, but as secondary, since he often found them only at a late period, the third or fourth day of suppuration. Kroner distinguishes two forms of blenorrhœa neonatorum, a more frequent one with gonococci, a less frequent one without this bacterium. Saenger and Fraenkel combat the diagnostic significance of the gonococcus, whose absence does not exclude blenorrhagic disease. Oppenheimer studied the influence of various anti-gonorrhoics upon gonococci pure cultures. In 1885 Lundstroem and Kries published similar experiments. The former examined 50 cases of acute and chronic urethritis, and always found gonococci. The virulent character of the gonococcus received further support from Martineau, Ferrari, Pezzer, Sinety and Henneguy. In 1886 Bockhart published investigations on 15 cases of "pseudo-gonorrhœal" urethritis, two of which were followed by epididymitis and were not produced by gonococci, but by other micro-organisms, as Bockhart proved by cultures and inoculation. Podres, Petersen and Crevelli furnished corroborating evidence based on large experience and numerous investigations, while Giovannini and M. v. Zeissl denied the specific character of the gonococcus. Schwarz (1886) pleaded for the gonococcus. Finally Bumm's treatise (1887) adduced abundant material and incontrovertible proof of the virulent character of the micro-organism.

And now, after this historical digression, we will direct our own attention to the gonococcus, and examine its nature and the proofs of its virulence. Neisser's gonococcus is a diplococcus. Under feeble powers and unstained the gonococci appear as round or elongated round fringe, 1.25 m. long, 0.7 m. broad, but which, under high powers and after staining, are

seen to be divided into two uniform halves by a bright line, a split. Each of these halves has an outer convex and an inner straight contour, both lie close to one another along the straight contour, so that only a thin slit remains between them. Each half of the diplococcus thus resembles a coffee bean. The gonococcus presents these characteristics in common with all diplococci. A further characteristic is furnished by the grouping. It is never grouped in chains, but is always found in small groups and clumps, and the number of single individuals in each group is not alone paired but is usually divisible by four. This grouping results from the peculiar mode of fission, as described by Neisser. Each diplococcus pair (Plate III., Fig. 4) divides in a line at right angles to the median fissure, so that from one diplococcus develop two double pairs, which are arranged like sarcina, but are usually a little more closely aggregated. Inasmuch as each single diplococcus pair again divides into a sarcina-like, double pair, and these shift from one another, groups develop in which many cocci pairs are still seen alongside one another in twos and twos. But these methods of division are also found in other diplococci. Like other bacteria, the gonococcus also possesses a great power of attraction for basic aniline colors, is readily stained by methyl violet, dahlia, gentian violet, fuchsin and methyl blue, but is decolorized with equal facility in alcohol and acids and Gramm's staining. This ready decolorization is a negative but extremely valuable diagnostic sign between the gonococcus and other forms of cocci, which usually retain a once imbibed staining much more vigorously and are not decolorized either by alcohol or acid, and particularly by Gramm's method. Roux (1886) recommended decolorizing according to Gramm, especially as a differential diagnostic sign. According to my experience the following is the best method of staining. The pus, which is spread upon the cover glass in the usual manner, dried and fixed by drawing it through the flame, is placed, with the charged side downwards, upon the solution of methyl blue. This is prepared by dropping a concentrated alcoholic solution of methyl blue into water or a solution of caustic soda (1:10000) in a watch glass until the fluid has a dark blue color. At the end of two minutes the cover glass is removed, washed with water, dried, and placed upon the object glass with Canada balsam. In this way the cocci appear dark blue and contrast very

distinctly with the grayish blue nuclei and the very pale blue protoplasm. Bumm recommends a practical rapid staining. The pus is spread in a thin layer upon the object glass with the blade of a knife, dried over the flame, drawn through the latter, exposed for half a minute to a concentrated watery solution of fuchsin, washed off, dried over the flame, and examined without a cover glass in the oil of the homogeneous immersion lens.

If we examine preparations of gonorrhœal pus treated in this way, we will usually be able to find numerous gonococci in groups, provided that the clap is recent and has not been treated. These groups are situated partly between the cells, partly—and this is characteristic of the gonococcus—in the pus and epithelium cells. Thus, we find cells in which a single group or a few groups of gonococci are situated in the protoplasm, usually near the nucleus. In other cells the number of gonococci is larger, they extend on one side or the other to the edge of the cell, but never beyond it, thus proving their presence within, not upon the cell body. Finally, other cells are so full of gonococci that they conceal the nucleus. When this takes place the cells burst and the groups of cocci escape from the cells. We then find not infrequently that groups of cocci are arranged around one, two or three cell nuclei, but without the sharp contour of the cell body; they are generally aggregated more closely towards the middle, more loosely towards the periphery.

In order to prove the specific character of these cocci, it is necessary not alone to demonstrate their constant occurrence in blenorrhagic secretion, but also to make pure cultures and inoculations with the result of producing a blenorrhœa. Apart from other observers who made statements concerning successful pure cultures, but whose nature as gonococci pure cultures was not proven by inoculation, or in which negative results were obtained, Bumm reports incontestable pure cultures. After several unsuccessful attempts this writer employed for cultures human blood serum, which he obtained from placentæ and sterilized in the well-known way. The pus of urethritis taken from the deep parts of the urethra, is spread in drops upon the blood serum, and the test tubes are then exposed to a temperature of 37° C. in the incubator. On the following day the gonococci have increased considerably in the drops which

have sunk into the blood serum. This secretion which is infiltrated with numerous gonococci, is now conveyed in drops upon delicately gelatinized blood serum, upon which the migration of the gonococci from the secretion to the blood serum takes place. The growth of the culture ceases at the end of two or three days, and reinoculations must therefore be performed frequently.

The coccus colony now appears as an almost colorless, thin, lac-like shining coating of the surface of the blood serum, which presents a somewhat characteristic appearance from the fact that it has a tendency to spread in numerous jagged, steep projections. Transference of the culture to meat infusion, pepton, gelatin, agar, always was attended with negative results. The gonococci did not grow in these media.

In two cases Bumm found that the conveyance of a second and a twentieth generation of a gonococcos pure culture to the female urethra produced a typical acute urethritis, the pus of which contained numerous gonococci.

Thus the etiology of gonorrhœa is well established, its virulence and virus are proven. We will discuss the occurrence and diagnostic significance of the gonococcus in the special part.

CHAPTER I.

BLENORRHŒA IN THE MALE AND ITS COMPLICATIONS.

URETHRAL BLENORRHŒA.

ANATOMICAL AND PHYSIOLOGICAL REMARKS.

BLENORRHŒA of the male urethra is probably the most frequent disease with which the practical physician has to deal. With it he usually begins his early practice, and until the end it causes him many anxious hours. Frequent as is the disease, it is equally ungrateful as regards a positive and radical cure. The practitioner is often told by his patients, either openly or by intimation, that he cannot even cure a clap, and the specialist often hears the same thing from his practising colleagues. A part of the blame attaches to the patient and to our social conditions, which render it impossible for the most honest and conscientious patient to follow all the medical directions without compromising himself, unless he were to undertake "a trip South for the restoration of his impaired health." But the physician is in great part to blame. We venture to assert boldly that there is no department of general medicine in which such unscientific and routine treatment is adopted as in the case of blenorrhœa. A clap syringe of tin, hard rubber or glass, a collection of thirty to forty recipes for injections, are the entire armament of the large majority of physicians. Certainty of diagnosis by examination of the pus and urine, the methods of physical examination of the urethra, are usually *terra incognita* in the pathology and treatment of gonorrhœa. No wonder, then, that this so frequent disease is a true *crux medicorum* and forms the "*partie honteuse*" of general medicine.

It is only within the last ten years that some light has been

shed upon this darkness. Our long-known anatomical and physiological data began to be made available in the pathology of urethritis; diagnosis and localization were thus placed upon a positive basis, and the indications for treatment were shown more clearly. Guyon, Otis and Ultzmann were pioneers in pathology, Desormeaux, Gruenfeld, Auspitz and Gschirhakl in endoscopy. The writer himself may, without conceit, pride himself upon having contributed his mite to the growth and spread of the new doctrines.

The more recent diagnosis, pathology and treatment of urethritis are based on an anatomical and physiological foundation.

It is not my purpose to write a detailed anatomical and physiological treatise. I will content myself with presenting those points in the anatomy and physiology of the urethra and bladder which constitute the immediate basis of our diagnostic and therapeutic action.

The question of the width, diameter and dilatability of the urethra is an important one. It is a generally recognized fact that the calibre of the urethra is not uniform but subject to variations. These are visible when the urethra is merely slit up, but are particularly noticeable in the introduction of instruments, even in the normal urethra; in such cases we cannot tell exactly when the normal calibre of the urethra ceases and it begins to dilate and accommodate itself to the instrument. We will therefore not furnish any figures, but will describe those conditions which are observed in examination of the normal urethra. If a perfectly normal urethra is slit lengthwise (Fig. 1), we find, on beginning at the orifice immediately behind the latter, a dilatation, the fossa navicularis, *a*, behind this the urethra is somewhat narrowed and passes through the greater part of the pars cavernosa with tolerably uniform calibre, *b*.

At its posterior extremity begins a spindle-shaped dilatation, the bulb, *c*. Posteriorly this terminates quite abruptly, where the urethra enters the isthmus, and, during its passage through the diaphragma urogenitale, the urethra, which here bears the name pars membranacea, *d*, has a tolerably uniform character. Immediately after the exit from the diaphragm, *i.e.*, at the entrance into the prostate, the calibre of the canal again increases and it forms a spindle-shaped dilatation, *e*,

which attains its greatest width at the caput gallinaginis, and, when the bladder is empty, again becomes somewhat narrower towards the entrance to the bladder.

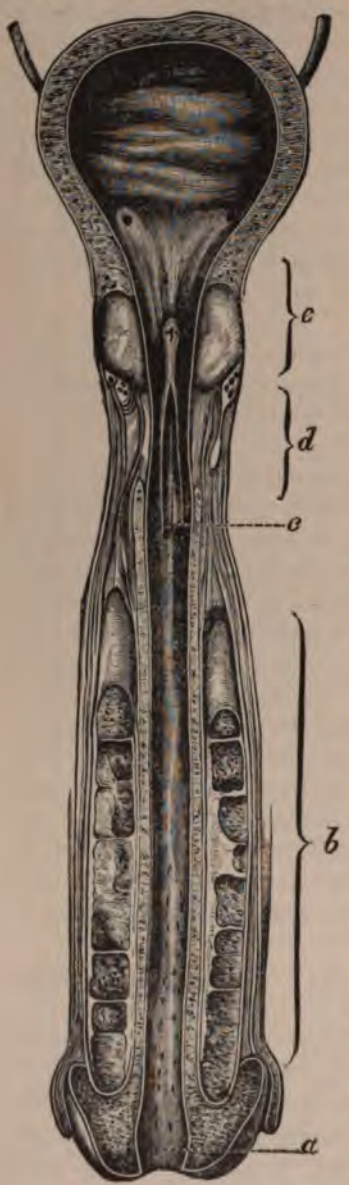


FIG. 1.

A mould of the urethra therefore consists of several parts; 1, the fossa navicularis, a spindle which is broken off anteriorly; 2, pars cavernosa, which is uniformly tubular; 3, the bulb, a spindle which is broken off posteriorly; 4, pars membranacea, a short tube; 5, pars prostatica, a symmetrical spindle.

Of all these parts the orifice of the urethra is the narrowest; its width is given at 8 millimeters (24 of Charrière's scale), but it is often narrower. Under normal conditions, a sound which has passed the orifice will always pass through the remainder of the urethra without obstruction. But if the orifice is wider, as sometimes happens, or if it has been dilated, as is sometimes necessary in operative procedures, we can convince ourselves that a much larger size may pass through the remainder of the urethra without hinderance; *the calibre or dilatability of the remainder of the urethra is much greater than that of the orifice.* This dilatability is not uniform, but differs in different parts. The pars membranacea comes next to the orifice, then the pars pendula, then the pars prostatica; finally the bulb, the widest and most dilatable. In order to meas-

ure the width of the various parts of the urethra in cases of narrow meatus and without dividing the latter, Otis and Weir devised the so-called urethrometers (Figs. 2 and 3). These consist of straight catheters which open at the visceral end either in a hemisphere or spindle, and are covered with a rubber cap in order to prevent pinching of the mucous membrane. A screw at the outer end effects the dilation of the hemispheres or spindle and indicates the diameter of the latter in numbers of the Charrière scale by means of a hand upon a dial plate. If such an urethrometer is introduced closed into the urethra—and this is done without difficulty by one who is expert in the introduction of straight instruments into the urethra—we are able, in the pars prostatica (as I have convinced myself in numerous examinations) to dilate the hemisphere or spindle to 30 or 32 of the Charrière scale, *i.e.*, to a diameter of 10 to 11 millimeters, without feeling any resistance or causing an expression of pain on the part of the patient. But resistance is experienced at once if an attempt is made to withdraw the dilated instrument and the pars membranacea is approached. Here the instrument must be screwed down to 27 or even 26 in order to pass without obstruction. At the bulb it again becomes possible to dilate to 32 Charrière. The pars cavernosa usually admits the passage of 28 to 30, and the orifice is only permeable to 24. These figures are not absolute, but only hold good relatively; we may give greater scope to the dilatation than that which I have given above and maintained in my examinations. The figures are then higher, but their proportions to one another remain the same.

Fig. 2. Fig. 3.

Thus Rollet (1862) gives the following measurements for the different parts of the urethra:

Orifice	7 to	8 mm.	21 to	24	Charrière.
Fossa navicularis . .	10 "	11 "	30 "	33	"
Immediately behind the latter .		9 "		27	"
Middle of pars cavernosa . .		10 "		30	"
Bulb		12 "		36	"
Pars membranacea (middle), .		9 "		27	"
Pars prostatica (beginning), .		10 "		30	"
" " (middle), . .		15 "		45	"
" " (end), . .		11 "		33	"

The importance of the calibre and dilatability of the various portions of the urethra will receive special attention in the section on diagnosis.

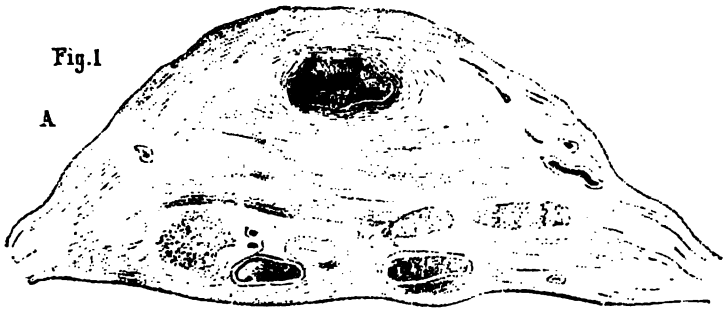
A second question which interests us deeply concerns the muscular apparatus of the urethra and bladder.

The urethra is usually divided into a pars pendula, bulbosa, membranacea and prostatica, but this division has only a secondary importance for us. The division of the urethra into an anterior urethra—up to the isthmus—and a posterior urethra—behind the isthmus—possesses great diagnostic and therapeutic significance. This division is not arbitrary, but has an anatomical, developmental and functional basis. Anatomically, because the structure and surroundings of both parts are essentially different. The anterior part, which includes the pendulous and bulbous portions, is surrounded by erectile tissue, whence it is also called pars cavernosa. In the posterior part, the erectile tissue becomes insignificant and the most prominent feature is the abundant surrounding muscular layer, whence the term pars muscularis. Both portions of the urethra are also essentially different from a developmental point of view. According to Picard (1885) the urogenital sinus forms the entire urethra in the female, and only the posterior urethra in the male. The formation of the anterior urethra is entirely independent. This develops from a nodule (phallus) which springs from the anterior wall of the cloaca, grows, and receives a groove on its lower surface, which closes in to form the anterior urethra. Finally, there is a functional difference between both parts of the urethra, inasmuch as the posterior part with its muscular layer forms an integral part of the uropœtic system, while the anterior urethra plays only a passive part in micturition, but, on the other hand, forms with its

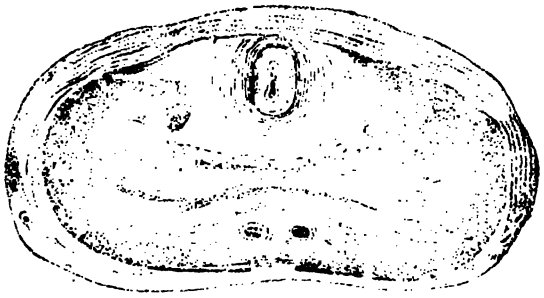
Finger: Plate I.

Fig.1

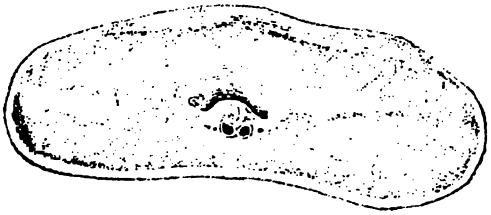
A



B



C



D

corpora cavernosa an essential portion of the sexual apparatus, and serves as the organ of copulation.

To what extent this division is justified in the pathology of blenorrhœa will be discussed in the appropriate chapters.

The quite simple anatomical structure of the pars cavernosa does not require our attention, but we must consider in detail the pars posterior seu musculosa.

We will first study its posterior portion, the pars prostatica. This owes its name to the surrounding prostate, an organ which is usually described as a gland, but possesses a much more complex structure. The investigations of the older anatomists, but particularly those of Henle (1863) and Langer (1885), showed that the inner surface of the prostate (which is directed towards the bladder) is formed by a sphincter composed of organic, smooth, muscular fibres, which is prismatic in shape, triangular on section and of very firm structure. It surrounds the urethra like a ring (Plate I, Fig. 1, A and B).

The smooth muscular tissue is mixed with numerous elastic fibres, and the network is made still denser from the fact that smooth muscular fibres as well as elastic fibres, which come from the bladder, cross these circular bundles. This smooth annular muscle is called the internal sphincter of the bladder, but preferably the internal prostatic sphincter. To the outside of this sphincter, *i.e.*, at the middle of the pars prostatica, the glandular portion of the prostate increases. It forms an acinous gland which, in well-developed cases, has the shape of a seal ring whose broad plate occupies the lower surface of the urethra, which is directed towards the rectum, while the narrow ring-shaped portion surrounds the urethra. The prostatic gland is rarely so fully developed; the upper portion, inclosing the urethra, is not quite complete, and the prostate there surrounds the urethra below and on the sides in the shape of a half-ring, which grows smaller above, but leaves the upper portion of the urethra free. This gland forms the boundary between the above-mentioned sphincter and a sphincter which, situated in front of the gland (the most anterior portion of the pars prostatica) occupies the apex of the prostate. Unlike the internal sphincter, this muscle—the external vesical or prostatic sphincter—is formed only in part of smooth muscle, but in great part of voluntary muscular fibres. The smooth fibres form a ring or network immediately in front of the

gland. The voluntary fibres at first appear only at the upper end of the urethra (Plate I, Fig. 1, C and D), and are in direct apposition to the gland or, as this is often absent, to the fibres of the internal sphincters. These fibres cross the urethra and form a muscular layer which passes transversely over the urethra, from one lobe to the other. Contraction of these fibres would approximate one lobe of the prostate to the other, but as this gland is very firm and but slightly flexible, the lobes form fixed points, and the arched muscle between them, in shortening, loses its curve, and becomes straight, and thus compresses the urethra from above downwards. These muscular fibres form what Krause and Kohlrausch call the transverse urethral muscle. To these fibres are soon added others, which surround the urethra laterally and below (Plate I, Fig. 1, E), and when the urethra leaves the apex of the prostate, it is entirely surrounded by a complete sphincter of voluntary muscle (Plate I, Fig. 1, F). This muscle, which is composed of smooth and voluntary muscular fibres, we call the external vesical or prostatic sphincter.

As soon as the urethra leaves the apex of the prostate it enters the urogenital diaphragm, which it leaves again at the isthmus, and within which it is known as the pars membranacea. Despite its title of pars nuda it is surrounded by a broad layer of smooth and voluntary muscular fibres. This muscular layer has received the most diverse descriptions and consideration at various times. Observed by Winslow and Santorini, Wilson (1821) was the first to study it in detail. Guthrie (1836), Mercier (1845), Demarquay (1849) give different descriptions, nor are concordant opinions found among the German anatomists Meckel, Mueller, Arnold, Krause and Kohlrausch, Hyell, Henle, Luschka, down to Lesshaft (1873). But the great abundance of muscular tissue in the pars membranacea is evident from all the investigations, however much they may vary in details. All accounts agree that it is covered by a broad layer of smooth muscular fibres, which consist of an inner layer of longitudinal, an outer layer of circular fibres. Henle (1863) puts the thickness of the longitudinal layer at 0.3 mm., of the circular layer at 0.75 mm.; Robin and Cadiat (1874) give 0.5 to 0.8 mm. for the former, 1.0 mm. for the latter. Outside of this is a broad layer of voluntary muscular fibres, whose individual strands surround

the urethra like a ring internally, while the outer fibres pass above and below the transverse urethral muscle from one side to the other; finally, other fibres, which come from the deep transverse muscle of the perineum, surround the urethra like a loop. This muscular apparatus is termed the musculus compressor partis membranacea, or, in brief, the compressor urethræ.

It is evident from the statements just made that the prostatic and membranous parts are usually in a condition of tonic contraction. This contraction is produced by the tonus of the smooth muscular fibres surrounding these parts, and can also be made visible very clearly through the endoscope. If this instrument is inserted into the most posterior portion of the urethra, up to the bladder, and is then gradually withdrawn while the appearance of the mucous membrane is being watched, we will see that the mucous membrane (which forms a funnel, starting from the visceral edge of the endoscope and with its lip directed towards the bladder) is continually closing up pari passu with the slow withdrawal of the endoscope, and leaves only a punctate lumen. This tonic contraction of the mucous membrane subsides during micturition by reflex action, but it can be markedly increased by innervation of the transversely striated muscular fibres which are accessible to the will.

Both posterior portions of the urethra are accordingly closed against the bladder, and their muscular tonus alone, which may be further increased by voluntary impulse, will suffice to prevent the escape of urine from the bladder.

Let us now consider the muscular structure of the bladder. Its three layers of smooth muscular fibres,—an inner layer of circular fibres, a middle layer of meshed fibres, and an outer layer of radially distributed fibres—will always produce diminution in the size of the bladder during contraction, and thus act as a detrusor. Has the bladder a special sphincter, and can it retain the urine independently without the intervention of the urethral muscular tissue? Anatomists have been occupied with this question for a long time. The attempt was made to construct such a sphincter of the bladder or to explain the closure of the organ in another way. Thus, Guthrie (1836) states that he could find neither circular nor spinal fibres at the neck of the bladder, and he is therefore of the opinion that

the vesical neck possesses little muscular contractility but marked elasticity. Civiale (1850) declares that the question of the existence of a sphincter at the neck of the bladder is the most obscure point in the anatomy of the organ. Anatomists express divergent views. Some assume the existence of a sphincter, but only by induction; others regard the ring at the collum as a mechanical obstruction. Civiale himself found circular fibres very inconstantly and sparely in this ring, and regards the main feature as a labyrinth of longitudinal and spiral fibres passing to the prostate. Barkow (1858) locates the occlusion of the bladder in the annulus elasticus cervicis, but, like the writer just mentioned, believes that the main occlusion of the bladder is formed by the muscular tissue of the pars prostatica and membranacea. Henle (1863) acknowledges the existence of a thin bundle of smooth muscular fibres at the neck of the bladder, but does not regard it as a sphincter; its contraction can have no other effect than to narrow the lower part of the bladder and to aid in the complete evacuation of the urine. Henle also places the real sphincter of the bladder in the prostate. Willich (1859) also accepts this view. Budge (1872) investigated the subject experimentally. He exposed the ureters in dogs and injected water through them into the bladder under such a pressure that it escaped through the urethra. This escape through the urethra ceased at once when Budge stimulated the muscular fibres of the pars prostatica and membranacea by means of electricity. If the urethra was divided immediately behind the prostate and the ostium vesicale stimulated, the escape of water was not checked. Hence the bladder possesses no special sphincter, the discharge of urine is not prevented by any part of the muscular apparatus of the organ, but entirely by the contraction of the urethral muscular apparatus. Therefore the bladder itself is not a closed organ, and it possesses no power of preventing the entrance of solid or fluid bodies which have passed the urethral sphincters or have been pushed by the pressure of the latter directly against the bladder. This fact is of great importance in the diagnosis and pathology of urethral blenorrhœa.

When empty, the bladder, on account of the tonus of its muscular tissue, forms a tensely contracted sphere whose mucous membrane is everywhere in contact, so that it possesses

Finger:

Plate

Fig. 2

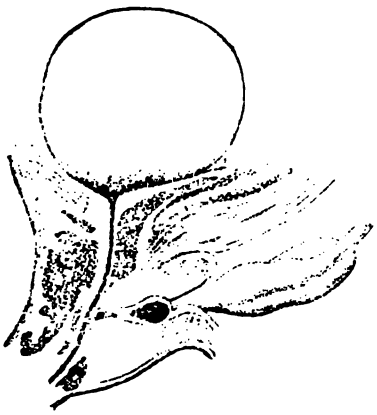
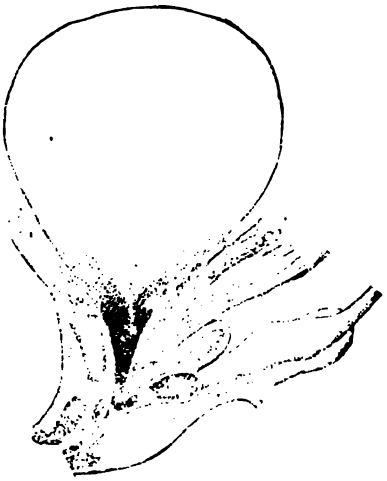


Fig. 3



no lumen or a very slight one. The pars prostatica also possesses no lumen on account of the tonus of its smooth muscular fibres. The bladder hangs upon the pars prostatica as upon a pedicle; there is a sharp boundary between the bladder and urethra. This configuration is not changed when the bladder begins to fill with urine (Plate II. Fig. 2). The pars prostatica remains closed, the bladder dilates and becomes more and more spherical, in proportion as the urine enters, an equilibrium being maintained between the pressure of the fluid within the organ and the tonic pressure of the muscular layer which is striving to contract. The fluid, being subject to this general tonic pressure of the muscular coat, is pressed against the orifice of the urethra, but this pressure can yet be overcome by the tonus of the internal prostatic sphincter and that of the elastic ring at the ostium vesicale. But as the distention of the bladder increases the pressure exerted by the fluid upon the ostium vesicale also increases, and finally becomes so considerable that it first overcomes the elasticity of the ostium and then the tonus of the internal prostatic sphincter, dilates the latter, and the fluid then begins to enter the posterior part of the pars prostatica. The hitherto sharp boundary between the bladder and urethra is abolished at this moment, the transition because a gradual one, and a "neck of the bladder" is formed.

The moment of entrance of the first drops of urine into the pars prostatica is also the time at which we feel the first desire to urinate. This desire is called forth by the irritation exercised by the urine upon the mucous membrane of the pars prostatica. There is absolutely no reason to believe that this desire can be stimulated from any point of the bladder, nor is this assumption justified by examination of the wall of the bladder with sounds and electricity, nor by our experience with patients, especially those suffering from calculi. All physiological and clinical experience shows that the pars prostatica, when irritated in any way, gives rise to the desire to urinate. Thus we know that this desire is violently produced during the introduction of bougies into the urethra as soon as they pass through the prostatic portion. All diseases of the prostate are accompanied by the most distressing vesical tenesmus. Examination of the prostate per anum and pressure upon it, even when normal, causes the feeling of a desire to urinate.

Injection of a few drops of a solution of nitrate of silver, touching and cauterization of the pars prostatica through the endoscope, always causes violent, often long-continued tenesmus.

The first desire to urinate, which is caused by the stimulus of the entrance of the first few drops of urine into the prostatic portion, can be overcome voluntarily by innervating the transversely striated muscular fibres of the external vesical sphincter and compressor. As the feeling intensifies with the increase in the amount of urine, it can only be overcome by the action of the entire perineal muscular layer, and the urethra as well as rectum become closed spasmodically. This is the reason that when there is violent rectal tenesmus, micturition alone is impossible, because every attempt to relax the sphincter vesicæ externus and compressor also gives rise to relaxation of the anal sphincters.

The urine which now collects will no longer remain in the bladder alone but will also accumulate in the pars prostatica, which takes a share in the enlargement, and the bladder assumes a pyriform shape more and more (Plate II, Fig. 3). The pressure of the fluid in the bladder will increase with the amount of fluid, and the increasing irritation experienced by the pars prostatica increases the desire to micturate.

On account of this inclusion of the pars prostatica in the bladder the urethra is considerably shorter when the bladder is full than when it is empty, a fact which I have demonstrated experimentally. If, in an individual who as yet experiences no desire to urinate, an elastic catheter is introduced into the urethra until the first drops of urine begin to flow and then the length of the portion of the catheter situated within the urethra is measured; and if the same procedure is repeated in this individual when the bladder is full and the desire to micturate already present, it will always be found that in the latter case the catheter need be inserted 2 to 3 cm. less deeply before the urine begins to flow—in other words, the urethra is so much shorter when the bladder is full. Repeated experiments, which I performed, as a matter of course, upon healthy individuals, showed that the length of the portion of the catheter within the urethra when the bladder was moderately full and the desire to urinate absent was 18 to 21 cm., when the bladder was very full and the desire to urinate pronounced, the length was only 16 to 19 cm. While, therefore,

the internal prostatic sphincter closes the bladder when the latter is empty or only moderately full, this function is performed by the external prostatic sphincter and compressor partis membranaceæ when the organ is full.

The compressor partis membranaceæ presents still further interest.

In the first place it plays an essential *rôle* in the, in part, physiological phenomenon which is usually known as urethral spasm.

If, in a healthy individual with a healthy urethra, a sound corresponding to the calibre of the urethra, *i.e.*, about No. 24 Charrière, is introduced, the bulb can usually be reached without any obstruction, but on passing into the isthmus urethræ, the pars membranacea, this is felt to contract in front of the instrument and to close tightly around it, and thus impedes the passage of the sound. The irritation which the sound exercises on the urethral mucous membrane causes a reflex contraction of the compressor partis membranaceæ. In nervous, irritable individuals this contraction may become really spasmodic and may make the further passage of the instrument impossible. We then speak of urethral spasm. Such a spasm may also occur when the mucous membrane of the urethra is in a condition of increased irritability as the result of inflammatory conditions, and in both cases the spasmodic contraction may be so violent that we are readily inclined to believe in the presence of a stricture. If smaller sounds are now introduced, their thinner and therefore more irritating tip will increase the spasm still more. This spasm may also be excited from behind, from the mucous membrane of the prostatic portion. This may happen in a perfectly healthy individual if, when the bladder was very full, he was compelled for a long time to overcome the desire to urinate and therefore to innervate the muscular fibres of the external prostatic sphincter and the compressor urethræ. When finally the moment for the possibility of micturition arrives, this does not occur promptly in many cases, at least in the beginning, and the urine is discharged in a thin, interrupted stream. The high pressure of the urine in the pars prostatica irritated the latter, and the irritation provoked reflex contraction of the sphincter apparatus, which only subsides pari passu with the diminution in the amount of urine

and its pressure, *i.e.*, with the diminution in the intensity of the irritation exercised upon the mucous membrane of the pars prostatica.

Such a reflex spasm of the sphincters is naturally produced much more readily when the pars prostatica is in a condition of increased irritability as the result of inflammation. In severe inflammations the mere irritation of the stream of urine is sufficient to produce partial or complete contraction of the sphincters and thus narrowing of the stream of urine or retention, as is seen not infrequently in blenorrhagic processes.

In all these reflex spasms, whether produced by pathological or physiological processes, the compressor partis membranaceæ is mainly affected, and they therefore occur particularly in the membranous portion of the urethra. In rare cases of extreme nervous or inflammatory irritability of the urethral mucous membrane, reflex contractions of smooth muscular fibres in the submucous tissue of the pars cavernosa, and therefore slight spasms may be produced. These interfere with the introduction of the sound or impede its advance.

Reflex spasms of the musculus compressor partis membranaceæ may be provoked, not alone by the irritation of a sound or bougie but also by the irritation and pressure of fluids. And thus we can usually succeed in injecting inert fluids into the urethra as far as the bulb, but their entrance into the membranous portion is prevented by the contraction of its muscular layer. This reflex contraction becomes more intense when the injected fluids are slightly irritant, such as astringents, and when the mucous membrane in question is in a condition of increased irritability as the result of inflammation. The contraction of the compressor partis membranaceæ is usually the cause of the fact that the fluids injected into the urethra for the treatment of acute urethritis enter as far as the bulb but not to the membranous and prostatic portions. Attention was called to this experience by Baumes (1840), Behrend (1848), Sigmund (1852), Diday (1859), Milton (1875), Guiard (1884), Bédoin (1886) and many others.

The musculus compressor partis membranaceæ, accordingly, divides the urethra into an interior open and a posterior closed portion. But in the same way that this muscle prevents the passage of fluid from the anterior into the posterior portion, it also prevents the escape of fluid from the posterior into the

anterior part. If such fluids are to be discharged they do not pass externally through the anterior part, but pass backwards into the bladder. Thus, blood and pus flow from the pars posterior back into the bladder, as do the fluids which we inject into the pars posterior. Diday (1839) proved this in a very ingenious way. If, in a healthy individual, a catheter is introduced into the slightly filled bladder until the urine begins to flow, the eye of the catheter is situated at that moment in the most posterior portion of the pars prostatica in front of the internal prostatic sphincter. To the outer end of the catheter is now attached a syringe containing about ℥j. of a lukewarm, perfectly bland fluid, and this fluid is slowly injected, the catheter being slowly withdrawn at the same time. We will then find that the fluid, which is thus injected into the pars prostatica, does not escape alongside the catheter (which we may purposely choose of small size, 16 to 18 Charrière) but passes into the bladder. So long as the eye of the catheter remains behind the compressor, all the fluid passes through the pars posterior into the bladder. On further withdrawal of the catheter the moment arrives in which it is difficult to inject any fluid at all. This happens when the eye of the catheter, in passing through the compressor, is closed by its spasmodic contraction; a moment later, when the eye of the slowly withdrawn catheter has passed the compressor and reached the bulb, the fluid begins to regurgitate alongside the instrument. With the aid of Guyon's "instillateur," an instrument with which we will become acquainted in the discussion on the treatment of urethritis, Jamin (1883) injected small amounts of fluid into the pars anterior and posterior, and states that when only two to three drops of inert fluid were injected into the bulb they made their appearance at the orifice of the urethra, while he could inject even forty drops in the posterior part behind the compressor, without a single drop appearing at the orifice. In order to demonstrate the regurgitation of small amounts of fluid from the pars posterior into the bladder, Casper (1887) deposited a few drops of yellow ferro-kalium cyanate into the pars posterior and, at the end of a little while, directed the patient to urinate at three intervals. None of the salt escaped at the orifice of the urethra. If it had remained in the pars posterior the first portion of urine would have washed away the

greater portion, the second portion would have contained only traces, and the third part would have been almost entirely free. Examinations of the urine with ferric chloride (Berlin blue reaction) showed the salt in all three portions of urine, but especially in the second and third portions, which, to judge from the change in color, contained almost equal amounts of the salt—a proof that a part, at least, must have passed into the bladder.

From all these data it is evident that the compressor muscle divides the urèthra into two sharply defined portions, which we call the pars anterior and pars posterior, a division which possesses very material importance in the pathology, symptomatology and treatment of clap in the male.

CHAPTER II.

ACUTE URETHRITIS.

INFECTION.

WE have learned that blenorrhœa is a virulent process whose virus is the gonococcus, and we therefore recognize only one condition as necessary to the production of blenorrhagic urethritis as of all blenorrhagic affections, *viz.*, the conveyance of gonococci in any vehicle, which usually, but not always, consists of the mucus or pus derived from another blenorrhagic affection.

Blenorrhagic urethritis can only develop by inoculation with gonococci. Its chief source is the transmission of blenorrhagic pus from the sexual organs of the female sex, and therefore coitus with a woman suffering from blenorrhœa of the sexual organs is the main source of blenorrhagic urethritis in the male. It is an evident *conditio sine qua non* that the woman from whom a man acquires blenorrhagic urethritis, must herself suffer from blenorrhœa. That this cannot always be proven on confrontation, results from the incomplete examination and from the fact that the disease is frequently latent and presents no symptoms in the female. This is especially true of chronic blenorrhœa. The fact that several men may acquire blenorrhœa from the same woman while others escape, that a man cohabits with a woman safely for a long time and then suddenly acquires blenorrhœa, although no changes have occurred in the woman, only proves that infection does not always take place, but that other conditions, favorable to infection, must be present. In their absence, or when conditions arise which antagonize infection, the latter will not take place. Blenorrhœa of the sexual organs in the female is therefore the most important source of blenorrhagic urethritis in the male, and coitus is the means of infection. Women who are more exposed to the acquisition of blenorrhœa

because they bestow their favors upon a number of men, are also more dangerous as regards the transmission of clap. According to Fournier's statistics (1866) infection was conveyed in 387 blenorrhœas in men by:

Prostitutes, public,	12
" private,	44
Mistresses, Actresses,	138
Working women,	126
Servants,	41
Married women,	26
	387

We see from these statistics that those women who are prostitutes without being under police control, do most towards the propagation of blenorrhœa, married women less, because they suffer less frequently, prostitutes little, because although they are often infected, the control and treatment rapidly make the infection harmless.

We have said that coitus is the chief agent in infection, but blenorrhœa can also be conveyed in other ways. For example, by unnatural sexual intercourse. Thus, Horand (1886) reports the following case: A medical student, previously perfectly healthy and never infected with blenorrhœa, had intercourse per os with a prostitute, but avoided other modes of sexual contact. A few days later pruritus of the orifice of the urethra was experienced, and a typical urethritis developed, in whose secretion numerous gonococci were demonstrated. Inasmuch as the genitalia as well as the buccal mucous membrane of the woman were found healthy on examination, Horand assumes that the gonococci were deposited in the girl's mouth during a previous coitus per os with a man suffering from blenorrhœa and were conveyed in this way. Langlebert, Clerc and Diday report similar cases.

Coitus per rectum may also convey blenorrhœa. Jullien (1886) relates that two friends had sacrificed to the same goddess. Orestes, who was to begin the sacrifice but knew himself to be unclean, would not, for the world, soil the sanctuary which Pylades was to enter after him. In order to avoid betraying either his secret or his friendship, he sacrificed to Venus Kallipygos. Pylades, who knew his friend's supposed

secret but was ignorant of his tender consideration, thought it was more prudent to deviate from the usual custom and sacrificed at the same altar as his friend. Orestes had long been consoled, while Pylades still shed abundant tears. Winslow (1886) reports an epidemic of urethral blenorrhœa which broke out in a boys' school. This was spread through pederasty, starting from an imported case of clap.

The manner in which the infection occurs was much discussed in former times. Wendt (1827) maintained that it occurred after ejaculation, by a sort of aspiratory activity of the urethra, and adduces in evidence the fact that some voluptuaries, who masturbated in lukewarm milk, had discharged from the urethra a few drops of milk just before the next micturition. Others assumed that the virus is absorbed by the glans, received in the urethra in the shape of a gas, sucked in before or after ejaculation, or that it only causes irritation externally. All these assumptions fall to the ground, since we know that direct transmission of the gonococci-containing vehicle is necessary to infection.

Whether contact of this vehicle with the orifice is sufficient for infection, or whether its entrance into the urethra, if only for a short distance, is necessary, must be left undecided. The latter seems more probable. But there are always certain factors which favor or interfere with the occurrence of infection. We know that not alone the transmission of the virus but also the suitable character of the soil is necessary in every infection. Even if the first condition is present, the receptivity of the soil may vary. In this regard one factor merits special consideration. A slightly alkaline soil seems especially adapted to the implantation and development of gonococci as of all other virulent micro-organisms. The mucous membrane of the urethra is always washed by an acid fluid on account of the urine which remains upon it. This amount would be sufficient to cause notable injury, during an ejaculation, to the semen, which is extremely sensitive to acids. But the urethra possesses special glands, which are particularly active during erection, and are designed to neutralize these acids. These glands are racemose and are situated in the meshwork of the corpora cavernosa. During erection this meshwork and the glands enclosed within it are subjected to the pressure resulting from the stasis of blood and distention of the corpus

cavernosum. This expresses from the numerous glands a clear, gelatinous, alkaline (not acid, as was stated by Sinéty and Henneguy, 1885) fluid, which covers the mucous membrane of the urethra, neutralizes the traces of acid, and may also escape from the urethra in the form of drops as *urorrhœa ex libidine.* This alkaline fluid also increases the receptivity for an invasion of gonococci, by making the soil alkaline, causing swelling of the epithelium, and facilitating the entrance of the germs. Hence infection is favored by everything that stimulates the secretion of this alkaline mucus. This includes protracted and repeated coitus and all factors which retard the occurrence of ejaculation, such as bodily strain or drunkenness. This is also true of coitus which has been preceded by long-continued sexual excitement and the attendant protracted erections, which are always accompanied by *urorrhœa ex libidine.* It is questionable whether infection is favored by a wide meatus or by the absence of ejaculation, which sweeps away the gonococci.

Among the factors which are unfavorable to infection must be mentioned, brief duration of coitus, the absence of repetition of the act, and micturition immediately after coitus. The latter rapidly acidulates the soil, and thus possibly removes the introduced gonococci from the membrane or even kills them.

To what extent stimulants, such as spicy food and drink, and cantharides, favor infection must be left undecided. At all events they may facilitate infection by causing protracted erections on account of the increase of sexual desire, and also by the stimulus to repeated and artificially prolonged coitus.

But the production of urethral blenorrhœa requires nothing more than the entrance of the gonococci in any vehicle into the urethra. And so a clap will result from the introduction of a gonococcus pure culture for purposes of experiment or in any other way, such as directly through the medium of articles of clothing, instruments, etc. We cannot deny the development of blenorrhœa in this way, although authentic cases of this kind are rare. Among the laity, however, there is a remarkable tendency to regard this mode of infection as frequent, and to accept the most impossible manner of infection rather than to accuse the mistress, or even a prostitute, of effecting the infection.

Symptomatology.

The entrance of gonococci into the meatus and perhaps also into the front part of the urethra causes an acute catarrhal inflammation of the mucous membrane with a typical course, which is known as acute urethral blenorrhœa or clap. How far does the disease extend along the canal? The older physicians did not think that the inflammation involved a large surface. For example, Swediaur (1798) believed that clap was located chiefly in the fossa navicularis, where it attacks the lacunæ of Morgagni, while all claps that are situated more deeply, at the curve of the penis, the veru montanum, neck of the bladder or bladder, resulted from improper treatment or some internal cause.

Later observers noticed that clap may extend further along the mucous membrane and may even attack the entire canal. Behrend (1848), the translator and commentator of Hunter, divided blenorrhœa into a blenorrhœa urethralis penis and blenorrhœa urethralis prostatica.

Even previous to this time Desruelles (1836) had gone further, and distinguished four kinds of blenorrhœa according to its location: 1, Clap of the most anterior portion; 2, clap of the pendulous portion; 3, clap of the bulb; 4, clap of the membranous portion. This classification, because artificial, found no support, and the opinion gradually gained ground that clap always extends along the entire urethra, from the external to the vesical orifice. Zeissl and Sigmund also advocated this view.

But this opinion did not remain unopposed. Langlebert (1864) claimed that clap is often confined to the cavernous portion of the urethra. Tarnowsky (1872) maintained that, in the majority of cases, the process does not extend beyond the boundaries of the bulbous portion. The same opinion was adopted by Mueller (1875). But it was especially Guyon (1883) and his pupil Jamin, who clearly proved the fact that acute typical urethritis is confined to the pars cavernosa, that the spread of the process to the pars posterior is an ominous complication, which does not belong to typical urethritis. This doctrine was developed on French soil by Aubert (1884), Erand (1885), Picard (1885), Bédoin (1886), Crivelli (1886), and transplanted to Germany by Ultzmann (1883), where it is com-

bated by only one opponent of note, *viz.*, Fuerbringer (1884). We have also become convinced that clap, in its typical course, extends to the bulb and no further. The extension of the inflammatory process to the pars posterior must be regarded as a complication, which produces deviations from the typical course, and may be the source of other serious sequelæ and complications, in other words, which change the symptomatology materially and aggravate its course.

The typical form, which extends only to the bulb, we call acute anterior urethritis, while the term acute posterior urethritis is used when the process extends to the pars posterior, and thus really over the entire mucous membrane, on account of the predominance of the symptoms which result from the affection of the posterior portion.

Acute Anterior Urethritis.

Acute anterior urethritis is a blenorrhagic inflammation, with a typical course, of the mucous membrane of the pars cavernosa and bulbosa urethræ. Beginning with slight symptoms after several days' incubation, the process gradually increases, at first in intensity, then in extent, and reaches its acme in both respects at the end of the second or beginning of the third week. It then diminishes gradually in intensity and extent in the same direction, *i.e.*, from before backwards, and terminates in five to six weeks.

Every blenorrhœa begins with a

Period of incubation, i.e., if an individual has been exposed to infection, the first symptoms do not occur immediately afterwards, but an appreciable interval of apparent perfect health, which is known as incubation, intervenes between infection and the first symptoms. This incubation is explained on the ground that the virus is conveyed in extremely small quantities, and in the beginning produces very slight symptoms which can neither be seen nor felt. But the virus animatum, having reached a favorable soil, increases rapidly, and the evidences of reaction increase in the same measure, until finally they reach the bounds of the visible. The incubation then ceases. The length of this period varies between quite considerable limits, and its determination is often made difficult by the uncertain and false (intentionally or otherwise) statements of the patient.

The following is the duration of incubation as shown by the statistics of 479 cases by Eisenmann (1830), Hacker (1850) and Hoelder (1851):

1 day in	11 cases
2 days in	59 "
3 " "	126 "
4 " "	62 "
5 " "	49 "
6 " "	10 "
7 " "	63 "
8 " "	12 "
9 " "	12 "
10 " "	23 "
11 " "	6 "
12 " "	8 "
13 " "	6 "
14 " "	19 "
19 " "	2 "
20 " "	1 "
30 " "	1 "
Uncertain in	9 "
	479

The greatest number of cases develop, therefore, on the third day, more than two-thirds within the first week (380 out of 479); a period of incubation longer than fourteen days is extremely rare.

In truth, the duration of the period of incubation varies, as a rule, between three and five days. It is usually shortest after a first infection, and generally becomes somewhat longer after subsequent infections, but it rarely exceeds six or seven days.

Extremely short periods of incubation, such as twenty-fours or less, are very suspicious. It is particularly suspicious as regards the question whether we have to deal, not with a fresh infection, but with a previous, apparently cured clap, which ran a latent course for a longer or shorter period and exacerbated on account of recent coitus, the exacerbation being regarded as a fresh infection.

Nor should statements concerning long periods of incuba-

tion be accepted without further inquiry. In such cases it usually happens that infection resulted from coitus performed a longer or shorter period before, and this was followed by subacute urethritis, which was overlooked by the inattentive patient. An excess in Baccho or some other noxious agent then brought the process to its complete acute development and this impressed the patient as the beginning of a fresh disease. It is also evident that the conduct of the patient in other respects will also influence the duration of incubation. Attention and sensitiveness on the one hand, recklessness, inattention and slight sensitiveness on the other hand, will cause the first morbid symptoms to be noticed sometimes earlier, sometimes later.

The period of incubation is important in so far as it draws a sharp line between virulent blenorrhœa of the urethra and all those catarrhs which, symptomatically like blenorrhœa, owe their development to mechanical and chemical influences and which develop immediately after such action, so that a period of incubation is absent. Thus, if a catheter or bougie is introduced into the urethra of a perfectly healthy individual and a sharply astringent or caustic injection is made, a purulent secretion, accompanied by inflammatory symptoms, will appear. Apart from the absence of gonococci this will be characterized by the fact that it begins at once or a few hours after the injection.

The transition from the period of incubation to the morbid process forms a longer or shorter

Prodromal Stage.—The patients experience a slight tickling or pricking at the orifice, both spontaneously and on urination, the orifice appears somewhat reddened and, if urine has not been passed for some time, the lips of the meatus are glued together, or a viscid, slightly grayish fluid appears between them in the shape of a small drop. In sensitive individuals slight general symptoms — depression, malaise, anorexia— occur at this time. These are probably of a psychical character, the result of a premonition of the things to come.

The prodromal symptoms are rapidly aggravated and pass into the

Florid Stage.—The mucous secretion at the orifice increases, but is gradually converted into a, at first, milky, then creamy pus. In a short time, usually at the end of the first week or

beginning of the second week, thick green pus appears, and its amount soon becomes so considerable that it exudes day and night in the form of large, heavy drops, and soils the genitalia and clothing of the patient. The inflammatory phenomena, of which the suppuration is a symptom, increase to an equal degree. The meatus and surrounding parts are reddened, the course of the entire urethra in the pendulous portion is swollen and tender on pressure; lancinating pains occur spontaneously, but are especially violent during erections. The latter are particularly frequent at night and extremely distressing to the patient. This is also true not infrequently of pollutions. On account of the swelling of the urethral mucous membrane, the stream of urine becomes very narrow, divided and split up, and the passage of urine along the urethra is extremely painful and attended by more or less intense burning along the urethra. All these symptoms increase until the end of the second week or beginning of the third week. At this time the inflammatory process has extended to the bulb. Pressure, and a feeling of warmth and fullness in the perineum, are added to the other symptoms, and their severity, together with the slight nocturnal rise of temperature and the insomnia due to the painful erections, reduce the patients, mentally and physically, not a little.

At this time—about the middle or end of the third week—the symptoms usually undergo a rapid change for the better in typical cases of acute anterior urethritis. The inflammatory phenomena and the subjective symptoms diminish, the secretion, although still profuse at first, becomes thinner and milky, later mucous, then diminishes in amount, and is reduced to a small amount of grayish mucus which glues together the lips of the meatus and is visible only in the morning. Finally, this disappears and the entire process may have undergone recovery by the fifth or sixth week after infection.

In severe cases deviations from the course just described may take place, inasmuch as, after the acme (third week) the inflammation spreads to the pars posterior, or after the terminal stage the process passes into a chronic stage.

In milder cases, especially under the favorable hygienic and dietetic conditions to which hospital patients are subjected, the process may be materially shortened without any other than, at the most, antiphlogistic treatment, because the proc-

ess does not occupy its entire territory, but is confined to a portion of the pars pendula, and without attaining its full development is completely cured in two to three weeks.

Even when the course is perfectly typical the intensity of the process varies extremely in different cases. Moderate suppuration, mild subjective symptoms consisting of slight burning during micturition and slight pain on erection,—and abundant, even sanguino-purulent secretion, almost constant pains, increasing very considerably on urination and erection, and not inconsiderable general symptoms, are the extremes. As a rule, the first infection is the most intense, later ones are milder; they rival the first attack in severity only when occurring at intervals of several years. As a matter of course the virulence of the conveyed secretion plays a part which should not be underestimated.

We will now consider the individual symptoms somewhat more in detail.

Inflammatory Symptoms.—If we examine the patient's genitals we will find, in mild cases, merely a slight redness of the orifice and the surrounding parts. The mucous membrane of the meatus is somewhat everted, as the result of the swelling, reddened, and covered with crusts of dried pus. In the severer cases the swelling is more pronounced, and is not confined to the vicinity of the orifice; the entire glans penis is swollen, reddened and in a condition of semi-erection. The ectropion of the mucous membrane is more marked, and the latter is excoriated and bleeds readily. The prepuce is œdematous, but has the normal color; or it may also be reddened, and the redness and swelling then extend more or less to the integument of the penis. Beneath the skin we not infrequently see and feel one or more strands, partly cylindrical, partly spindle-shaped, which may attain the thickness of the little finger. These are painful on palpation and may be traced to the symphysis. The integument over them may be still movable, but it is often adherent to the strands, especially when it is also reddened and œdematous. These strands, which often take their origin from the frenulum, pass around the coronary sulcus in an arch and unite in the median line of the dorsum, are inflamed lymphatics (acute lymphangioitis). This affection, although very painful—it is attended by painful tension, particularly during erection—is a relatively harmless and in-

significant complication which usually undergoes rapid resolution.

The urethra is more or less swollen along its entire course, and pressure upon it is painful, particularly in the region of the fossa navicularis. Along the course of the urethra we often feel more or less numerous nodules as large as a millet seed, consisting of swollen follicles which, in very acute cases, are often arranged in rows like a rosary.

Secretion.—This is the most constant, often almost the sole symptom of blenorrhœa. It varies according to the stage of the process, and the abundance and purulence of the secretion are the most important gauge of its intensity.

The secretion is muco-purulent. Its abundance is proportionate not alone to the intensity but also to the extent of the process. Slight at the onset, the amount increases from day to day, reaches its maximum with the acme of the inflammatory process or somewhat later, and then gradually diminishes. It is often very considerable at the height of the disease. When the patient stands before us stripped, the pus not infrequently wells out in drops from the urethra. The amount of secretion varies not alone according to the stage of the disease, but also according to the time of day. Most patients notice that the secretion is greatest in the morning, diminishes towards noon and is least at night; it then increases again until morning. These variations in the accumulated amount of secretion depend in part upon the time allowed for its accumulation. It will depend evidently on the intervals in which the urethra is cleansed of secretion by urination. The fact that the patients generally urinate either not at all or only once during the night is brought into causal relation with the fact that the morning secretion is the most considerable. This relation is undeniable, but it is not the only cause of the increased morning secretion. Accurate observations have shown that in the course of every acute clap nocturnal exacerbations and diurnal remissions alternate periodically. The amount of pus found in the morning is always considerable, even if the patients micturate between three and four o'clock and thus discharge the pus. If they retain the urine five or six hours during the day, the accumulation of pus is never as great as in the morning. The inflammatory symptoms are also aggravated at night. Patients who are constantly in

bed, as in the hospital, may sleep quietly for several hours during the day, without being annoyed by erections, but they are hardly asleep at night before they are awakened by an erection.

But these exacerbations and remissions are not so distinct in patients who remain permanently in bed. For this reason I believe that the nocturnal exacerbation is due in part, though not entirely, to the noxious influences of the day.

The amount of secretion may be gauged from that which escapes from the meatus, but accurate data concerning the quantity and nature of the secretion are also furnished by examination of the urine, which presents essentially different appearances in the different stages of the disease.

We will first emphasize, from a diagnostic stand-point, the fact that in acute anterior urethritis the production of pus takes place in the pars pendula and bulbosa. If the pus is produced in large quantity it will escape from the orifice of the urethra, and its passage from the bulb into the pars posterior is impossible. If a patient who is suffering from anterior urethritis passes urine, the pus accumulated in the urethra will be swept away by the first stream, which thus becomes cloudy. The urine passed subsequently finds the urethra free from secretion and therefore remains clear. If we perform Thompson's test with the two glasses, *i.e.*, direct the patient to pass the urine in two parts into two beakers, the first urine passed alone will contain secretion, the urine in the second glass will remain clear.

The nature and amount of this secretion are shown much more clearly by examination of the first urine passed than by looking at the secretion as it wells up from the urethra. In the prodromal stage the secretion is slight and mucous; it is rolled together by the urine, in which it appears in the shape of fine or coarse threads, clap threads. The amount of secretion gradually increases and becomes more purulent, its color grows milky. The urine is then more or less cloudy, and if allowed to stand, two layers are seen at the bottom of the vessel. The lower one is a narrow, firmer layer of pus composed of small, yellowish-white clumps; the upper layer is a broader, looser, grayish layer of mucus, above which the urine itself looks clear. The more purulent the secretion, the more the width of the mucous layer diminishes and that of the

purulent layer increases, and in the purulent stage, at a time when the abundant secretion is deep yellow or even greenish yellow, the sediment, which is usually deposited rapidly, is only purulent. As the process improves the purulent secretion becomes muco-purulent, then mucous, and diminishes in quantity; in the mucous terminal stage we find only a few shreds of mucus and pus in otherwise clear urine.

Microscopical examination of the secretion furnishes interesting data concerning the morphological constituents and the presence of gonococci.

In the beginning the mucous secretion of the prodromal stage or the shreds collected from the urine contain (Plate III., Fig. 5) chiefly large, rhombic pavement epithelium and only a few pus cells. The gonococci, which are usually present in no small numbers, are in great part free, in part are situated upon or more rarely within the epithelial cells, and also within the pus corpuscles.

In the stage of muco-purulent secretion, the number of gonococci first increases, then the pus corpuscles; many pus cells are more or less filled with gonococci. Free masses of the cocci are rare, and when present they can usually be distinctly recognized as derived from the destruction of pus cells which had been filled with the organisms. Pavement-epithelium cells are scanty and usually more or less filled with gonococci. Oval, polygonal and cuboid, mononucleated transitional epithelium, also partly filled with gonococci, are more numerous.

At the height of the process (Plate III., Fig. 6) all other cellular constituents diminish in comparison with the pus cells, which are present in large numbers and dominate the field. The number of gonococci also seems smaller, although there are still a large number of gonococci-containing pus cells. I do not think that the number of gonococci diminishes at this stage, but the relatively more rapid production of pus corpuscles makes their number appear smaller. Podres (1885) states that in one series of cases, at this stage, he found all the gonococci in pus cells and very few free ones, in a second series of cases the majority of the gonococci were free. The first series ran a mild, the second a severe course. In the numerous examinations which I have made, I have been unable to confirm these statements, especially their prognostic significance.

In the terminal stage (Plate III., Fig. 7), the number of

gonococci and pus cells becomes smaller, transition epithelium cells are numerous, pavement epithelium scanty. The serous secretion and shreds of this stage consist mainly of transition epithelium, a few gonococci and pus corpuscles.

And thus the microscope furnishes no unimportant data concerning the duration of the process. If the orifice is slightly reddened and a slight mucous secretion is present, while the microscope shows that the secretion consists of abundant flat epithelium and numerous gonococci but few pus cells, we have to deal with a recent, beginning infection. If, with the same symptom complex, the secretion contains numerous transition epithelium, few pus corpuscles and gonococci, the process is approaching recovery.

The presence of numerous pus corpuscles and gonococci are evidence of the severity of the process, while few gonococci make the disease appear milder. But in order to draw any conclusion concerning the intensity of the process from the number of gonococci, we must examine a large number of preparations from the same day. The gonococci are not distributed uniformly in the pus, they are more abundant on one slide, less abundant on another, so that if we are satisfied with the examination of a few slides, we are apt to arrive at the opinion that their occurrence is intermittent and variable, while, on the whole, the number present in the pus runs quite a parallel course to the severity of the process. In the examination we should always use the pus which is obtained from the deepest part of the urethra by pressure from the outside. Apart from the fact that we thus avoid contamination with the bacteria, which are always present in the pus of the orifice, we obtain the pus from the most recent and freshly inflamed parts. This always contains more gonococci than the pus of the anterior parts, in which the inflammation has perhaps passed its acme at the time of examination.

Subjective Symptoms.—These are very variable. The most frequent and characteristic symptom is pain during urination. This varies according to the degree of inflammation. In the beginning it is slight and manifested by a mere feeling of warmth during the passage of the urine and for a little while afterwards. This is soon converted into a real sensation of pain. It is especially at the moment when the first drops of urine separate the swollen mucous membrane of the ure-

Finger:

Fig.4

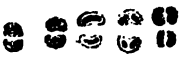


Fig.5

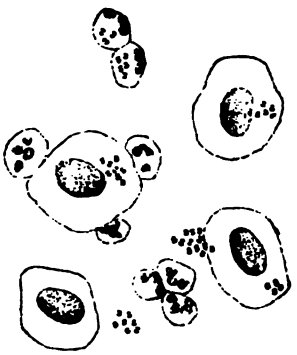


Fig.6

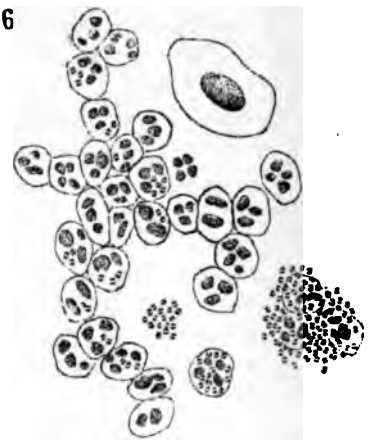


Fig.7

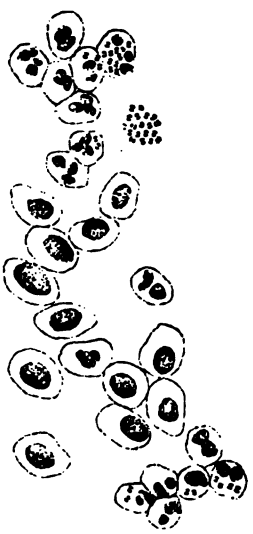
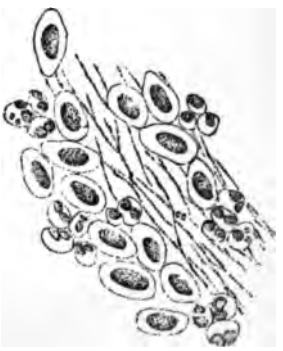


Fig.8



thra that a burning pain is felt, at first not violent, but rapidly increasing in severity. At the height of the inflammation this feeling is so violent that the patients delay urination as long as possible, and hardly drink any fluids in order to avoid micturition. The common French term "chaude pisse" and the English "burning" owe their use to this symptom. After the acme of the inflammation has passed, the pain soon subsides and disappears long before the suppuration. In exceptional cases the pain may be slight despite abundant, even greenish suppuration, while slight suppuration is sometimes attended with violent pain.

The pain is located in the entire pars pendula, but one point, usually the orifice or fossa navicularis, more rarely the peno-scrotal angle, is generally mentioned as the chief site of the painful sensation. In some cases, finally, the pain, which began during the acute stage, remains long after the general inflammatory symptoms have subsided.

In addition to the pain on micturition spontaneous pains also occur. Before the affection reaches its acme these pains are especially distressing, and consist partly of entirely spontaneous, lancinating pains along the pars pendula, partly of pains which are produced by pressure, improper position of the penis, movement and the sitting posture. In severe cases they extend into the testicles, groins and along the seminal ducts, and impede every movement of the patient.

Sexual Irritative Symptoms.—These are hardly ever absent in a case of acute urethritis. They begin in the prodromal stage and manifest themselves by morbidly increased sexual desire, more frequent and vigorous erections, increased impetus coeundi. This not infrequently leads to indulgence in sexual excesses, which are usually associated with increased voluptuous sensations. But this condition, which is usually not disagreeable to the patient, does not last long. When the inflammatory symptoms are fully developed, the increased sexual excitability constitutes one of the greatest sufferings of the patient. As in the prodromal stage frequent and very vigorous erections set in, but the swelled mucous membrane of the urethra does not answer to the demands for space caused by the elongation and broadening of the tensely filled corpora cavernosa; it has lost some of its elasticity. The patients therefore complain, at each erection, of a feeling of distention and drag-

ging of the urethra. If we have the opportunity of examining the rigidly erect penis in this stage, we find not infrequently that the meatus and surrounding parts are drawn, in a funnel shape, into the urethra by the rigid mucous membrane. This feeling of tension increases to one of considerable pain by clonic contractions of the ischio-cavernosi and bulbo-cavernosi muscles, whose action not infrequently forces the penis, like a pendulum, against the abdominal walls. But it is particularly the moment of ejaculation, during the pollutions provoked by the sexual irritation, that is attended by violent pain. If the inflammation and sexual irritation are violent, the intense erections and the consequent ejaculation of semen may produce direct ruptures of the mucous membrane, hemorrhages, and thus a bloody color of the pus and semen—a condition which is known as Russian clap.

The sexual irritation is constant. Every external influence which stimulates the sexual sense may produce erections very quickly in patients in this condition, even when normally of a cold disposition. The erections are especially provoked by the heat of the bed. Hardly has the patient, who is usually filled with dread of the coming night, gone to bed and fallen asleep, when the first erection ensues and he is rudely awakened by the pain. When walking on the cold floor, the application of cold compresses, etc., have relieved the erection and the patient again retires, the erection appears anew and the night is thus full of misery.

Not infrequently the erections are constant and last for hours or half a day. If the corpus cavernosum urethræ, on account of the swelling of the urethral mucous membrane, cannot follow the increase in size of the corpora cavernosa penis, this gives rise to deformity in the shape of the organ. In the mildest grade the glans alone is bent downwards (this was called "une gland arqué" by Ricord); in the severer forms the entire penis assumes an arched shape, with the concavity downwards. This is the condition known as chorda venerea. In contrast to the inflammatory chordee due to inflammatory irritation of the corpora cavernosa, this is also known as spasmodic chordee, because some observers, such as Milton, Koelliker and Hancock, do not regard it as a purely passive process, due to diminution in the elasticity of the urethral mucous membrane, but as a spasm of the longitudinal fibres

of the smooth muscular layer in the submucous tissue of the urethra.

Chordee is one of the most distressing symptoms of acute urethritis. The pain explains the brusque manner in which the patients endeavor to rid themselves of it, by placing the curved and erect penis upon a hard substance and endeavoring to straighten it by a blow of the fist. Breaking chordee in this manner is an extremely old custom. Abu Oseiba mentioned it in 940 A.D. This practice is usually disastrous to the patient. The violent injury generally causes rupture of the urethra with violent hemorrhage, perhaps followed by inflammation of the corpora cavernosa, or at least by cicatricial stricture of the urethra after recovery. Paul (1875) and Jullien (1886) mention such cases. Voillemier lost a patient from the hemorrhage. One of Duforn's (1854) patients performed coitus when suffering from chordee. Severe hemorrhage set in afterwards, the penis became swollen, ecchymoses in the skin appeared, and dysuria set in. Despite vigorous antiphlogosis, gangrene of the penis set in, cystitis and death after typhoid symptoms. The autopsy showed ammoniacal cystitis with ulcerations, pyelit s, and suppurative nephritis; the urethral mucous membrane was torn 3 cm. and 6 cm. from the orifice, the lower rupture led into a gangrenous cavity. Similar symptoms may also occur after chordee without external injury. Villeneuve (1873) reports a case in which chordee was followed by gangrene, and this by pyæmic symptoms, phlebitis of the prostatic plexus, metastatic abscesses in the liver and lungs, and death.

Disturbances of the Discharge of Urine and Semen.—The notable diminution of elasticity, associated with swelling of the urethral mucous membrane, causes disturbances in the discharge of urine and semen. The swelling of the mucous membrane produces narrowing of the lumen, which becomes so much more evident because the patient does not employ abdominal pressure on account of the pain. The urine is therefore evacuated in a narrow, feeble stream, which, when the pain is great, is often interrupted on account of the reflex contractions of the compressor urethræ. When the inflammatory symptoms are pronounced, the irritation of the first drops of urine may be so intense that reflex contraction of the compressor occurs at once and continues spasmodically for some time. True

dysuria may develop, inasmuch as this spasm occurs with every attempt at micturition. The diminution in the elasticity of the swollen urethra is also a cause of the insufficient movement and slow discharge of the urine, but it is especially the last drops in the rigid tube formed by the swollen mucous membrane which remain behind and only escape gradually. Incontinence is thus a not infrequent symptom of urethritis. Ejaculation is impeded in the same way, and the semen escapes slowly and drop by drop from the urethra.

General Symptoms.—Blenorrhœa, however severe, always remains a local disease. Nevertheless its acute stage is always accompanied by a series of usually mild general symptoms. Slight chilliness, fever of slight grade (rarely over 38°), malaise, anorexia and mental depression develop. The appearance of the patient usually suffers; he has a sallow, yellow complexion, and the sunken eyes, with rings around them, disfigure the hitherto healthy and robust individual. Many of these phenomena are the result of psychical factors, the insomnia due to the sexual irritation, and the changed mode of life, especially the abstinence from alcoholics. But these factors do not explain the general symptoms entirely. The direct migration of gonococci into the blood is hardly conceivable, but it cannot be denied that the vital processes carried on by the cocci in the urethral mucous membrane may produce chemical substances (ptomaines) which pass into the circulation and produce a toxic effect.

Course.—The regular course of acute anterior urethritis as just described is not observed in all cases, and it might even be regarded as exceptional.

In the typical course a period of incubation of three to five days is followed by a prodromal stage of hardly two days. The then beginning blenorrhagic process increases in severity for about fourteen days, reaches its acme in the third week, and recovers at the end of two to three weeks, the entire process thus lasting five to six weeks. There may be variations, however, in every stage of the disease.

The period of incubation may be somewhat shorter or longer; the prodromal stage is less subject to change.

The length of the acute period until the height of the disease may be very materially prolonged, even though the process does not extend beyond the pars anterior.

This prolongation may result from the longer course of the entire acute stage, so that three or even four weeks may elapse before the disease reaches its height. It then looks as if the inflammation spreads more slowly over the entire mucous membrane.

Or the process reaches its acme at the usual time (about the middle of the third week or even earlier), but remains there for a week or more, instead of a few days.

The course of the disease is much more often prolonged by disturbances in the course of the last stage. In typical cases the disease diminishes uniformly in intensity and extent, after the acme, in about three weeks. In many cases, however, this improvement is not uniform but interrupted. The disease improves, then remains at a standstill for a time, again improves, and so on.

In equally numerous cases recovery is interrupted by relapses. The process has passed its acme and made a step towards recovery, when suddenly a relapse sets in. The acuteness of the process, the secretion and subjective symptoms increase, and a second acme is reached, usually less pronounced than the first. Thus several relapses, whose intensity usually grows less with each succeeding one, interrupt the course of the disease until finally recovery is established. These relapses may even occur during the terminal mucous stage of clap.

The causes of this abnormal course are partly external, partly in the patient. It may result from constitutional anomalies. Scrofula, cachectic frame, poor nutrition, and syphilis delay the course of clap even without external noxa, and are at the bottom of numerous relapses. But pollutions are the most frequent cause of a protracted course. The physician then finds himself confronted by a vicious circle, which is not always easily broken. The acute process causes erections and pollutions; these increase the acuteness of the inflammation and thus prove a renewed cause of increased sexual irritation. If the pollutions are numerous in the acute stage they intensify the inflammation; if they occur at the acme they prolong the latter, and in the terminal stage they are the cause of frequent relapses.

External causes may prolong the disease in a similar way. Coitus acts in an analogous manner to pollutions, as do ex-

cesses in Baccho, ingestion of spicy food, exhausting exercise, walking, riding, driving and dancing.

Intercurrent diseases also affect the course of blenorrhœa. In acute diseases all the symptoms cease so long as the fever continues. It seems to be cured, but returns after the cessation of the fever. Acute general diseases, which cause great prostration of the body, favor a protracted course of clap, and certain affections, particularly typhoid fever, are apt to cause very acute inflammation or even gangrene in urethritis (Hoelder, 1851). Colds, digestive disturbances, particularly intestinal catarrh, aggravate the course of clap. Finally we may mention that in severe jaundice the pus of gonorrhœa not infrequently possesses a deep, saffron-yellow color, which disappears with the removal of the jaundice.

Varieties.—We have already said that the severity and duration of the disease are subject to material variations. It is well to distinguish three large groups, which merge into one another.

1. *Subacute Form.*—The first infections rarely, repeated infections more often, assume a subacute torpid course from the start. The incubation and prodromal stages last longer, the intensity of the inflammatory stage is less, the pain, sexual irritative phenomena and general symptoms are almost or entirely absent. The secretion long remains serous, opalescent, gelatinous, although its amount may have increased. It never becomes more than muco-purulent, although pus can always be demonstrated microscopically and macroscopically at some stage, and I doubt the existence of a purely mucous catarrh after blenorrhagic infection. Gonococci can always be found quite abundantly in the secretion; in the beginning the flat and transition epithelium cells persist very long and always contain gonococci. The number of pus cells is relatively small. The impression is created in these cases as if either the virus is weak or the receptivity of the soil is diminished and the gonococci have penetrated less deeply, so that epithelial desquamation suffices for their removal, and irritation of the papillary body with secondary emigration of pus cells occurs only to a slight extent. This form is as insidious as it is mild in its manifestations. The subjective symptoms are so slight that they are often entirely overlooked by the patient. Noxious influences may give rise to exacerbations,

but these are often only temporary. And so the process spreads not infrequently to the pars posterior, and there gives rise to the development of subacute and chronic urethritis posterior and prostatitis.

2. *Acute Form.*—Purulent clap, the type of the acute urethritis as described by us, and is especially observed at the first infection.

3. *Peracute Form*, or phlegmonous clap, with intensification of all the objective and subjective symptoms. Incubation and the prodromal stage are short, the symptoms of the acute stage intense. Marked swelling of the entire penis with œdema of the prepuce, lymphangioitis, abundant purulent secretion, associated in rare cases with the exfoliation of croup-like membranes, or a reddish brown to black color of the pus on account of admixture with blood, marked symptoms of sexual irritation, chordee and pollutions, intense pains, pronounced implication of the general system; the number of gonococci in the secretion is often enormous.

Posterior Acute Urethritis.

In discussing the course of acute anterior urethritis we have mentioned that the inflammatory stage increases up to a certain point, and then slowly diminishes to complete recovery. The amount of secretion in the urine varies in a corresponding manner. If the test of the two vessels is made, the first urine passed alone is cloudy, the second is clear, and there is always a correspondence between the amount of pus escaping from the meatus and the cloudiness of the urine. The reason is evident. The pus produced in the pars anterior can only cloud the first urine, and not being retained by any muscular force, it must flow towards the orifice of the usually pendulous urethra.

In the third week occurs the turning point in the course of urethritis, the acme which, whether longer or shorter in duration, always forms a boundary stone, which is indicative of a change. We are already acquainted with the change for the better, but a change for the worse may also occur. The blenorrhagic process, hitherto confined to the pars anterior, passes the compressor urethræ and extends to the pars posterior. The blenorrhœa thus attacks the entire urethral mucous membrane to the ostium urethræ vesicale.

With this transition the blenorrhagic process has become a much more severe disease. The typical course has not ceased altogether, but it is rarer. Disturbances of the typical course by complications and spread of the blenorrhagic process are more common, the prognosis more serious, the treatment is more difficult.

The spread of the disease to the pars posterior occurs at a time when the acuteness of the process in the pars anterior is diminishing and does not interfere with the latter. On the contrary, I am inclined to maintain that the development of posterior urethritis favors the rapid termination of anterior urethritis. Disease of the pars posterior spreads quite rapidly over the entire mucous membrane, and rapidly attains its maximum, but recovery then occurs very slowly, after a usually long protracted subacute stage. In other cases acute symptoms are absent and the course is subacute and protracted from the beginning.

The direct anatomical connection of the short pars posterior with a number of other organs, the prostate, bladder, seminal vesicles, epididymes, offers the most favorable condition for the spread of the inflammatory process, and urethritis posterior is often merely a temporary forerunner of cystitis, prostatis, vesiculitis, epididymitis.

Whenever these complications occur, posterior urethritis is always present. The latter is the agent in the production of these processes, but they may develop together, *i.e.*, posterior urethritis and prostatitis, cystitis and epididymitis may appear almost at the same time. Or the development of posterior urethritis may precede these complications for a long time. Thus, the former may almost have run its course, then relapse on account of external noxious influences, and the first or even a subsequent relapse may give rise to the development of the complications mentioned.

I have already said that posterior urethritis occurs after the acme of anterior urethritis. It does not develop, therefore, before the beginning of the third week after infection, except under special circumstances, as, for example, examination of the diseased urethra with the sound and direct transport of blenorrhagic pus to the posterior portions of the urethra at an earlier period.

As a matter of course it may develop at a later period. It

does not develop necessarily after the first acme, but may follow a relapse of the anterior urethritis.

The causes of the development of posterior urethritis are internal and external.

Internal causes are to be looked for in the constitution of the patient. In cachectic individuals, those suffering from chronic diseases, such as tuberculosis, scrofula and syphilis, anterior urethritis is generally followed spontaneously by posterior urethritis, usually about the third week. Even without a decided cachexia the urethra of some individuals forms a favorable soil for the virus, and it is particularly blonde, slender individuals, with a tendency to catarrh in general, who also have a tendency to the development of posterior urethritis. It is also certain that an individual who has once suffered from posterior urethritis, will again be attacked by it during the course of another infection.

In all these cases the extension of the disease occurs immediately after the first acme, *i.e.*, in the third week, and usually without any noticeable subjective symptoms.

All the external causes which give rise to an exacerbation or relapse of anterior urethritis, excesses in venere and Baccho, spicy food, alcoholics, pollutions, excessive exertion, may also cause the spread of the process to the pars posterior. Under such circumstances the latter usually develops brusquely, with notable subjective symptoms.

If the anterior urethritis had been reduced to slight symptoms at the time of the action of the irritant, exacerbation of the former usually remains absent in case posterior urethritis develops.

The relative frequency of anterior and posterior urethritis cannot be accurately determined. Leprevost (1884) claims to have observed posterior urethritis in $\frac{1}{6}$th, Eraud (1886) in $\frac{4}{5}$ths of all cases.

If the extension of the process to the pars posterior occurs without symptoms, the anterior urethritis appears to run its normal course and to approach recovery. But one symptom will not escape us if the patient is examined with any degree of care. On examining the urine it will be found that the cloudiness is considerable when compared with the diminishing suppuration visible at the orifice of the urethra. This circumstance alone is an indication that, in addition to the small

amount of pus produced in the pendulous portion, and which can cause only slight cloudiness of the urine, the cloudiness must be due to some other cause.

If we now make the test of the two beakers, *i.e.*, direct the patient to pass the urine in two portions, not alone will the urine in the first glass be found very cloudy, but also that in the second glass, though to a much less extent.

The latter can result only from cloudiness of the urine in the bladder. All the pus which remains in the urethra is washed away by the first stream of urine, and if the urine in the bladder itself is clear, that passed into the second vessel must also be clear.

The pus of anterior urethritis can freely escape externally, but its entrance into the bladder is prevented by the firm closure of the compressor. What becomes of the pus produced in the pars posterior?

The tonus of the pars membranacea and prostatica normally closes these parts in such a way that no lumen, or only a capillary one, is present. This tonus is still further increased by the inflammatory irritation, and the accumulation of large amounts of pus is therefore impossible.

The pus of the pars membranacea will endeavor to escape from the tube which compresses it on all sides, and will therefore flow forwards into the bulb, backwards into the pars prostatica.

The pus of the prostatic portion will endeavor to escape in the same way. Its escape anteriorly is prevented by the tonic contraction of the pars membranacea. There is no obstruction posteriorly, because the bladder is not closed against the urethra and possesses no power to prevent the entrance of solid or fluid bodies from the prostatic portion. The pus of the pars prostatica will therefore enter the bladder and cause cloudiness of the urine accumulated there. Another circumstance must be taken into consideration. So long as the bladder is moderately filled the pars prostatica remains closed. But when the bladder becomes fuller the pars prostatica is used for the reception of the urine. It is therefore evident that the pus produced in the pars prostatica and in part deposited in it will be mingled with the urine in the bladder. The cloudiness of the urine will therefore be most marked when prolonged retention of urine permits the formation of

larger amounts of pus. On the other hand the pus will only enter the urine when its amount is so large that it no longer finds room in the pars prostatica. When micturition is frequent, and when only small amounts of pus are produced which could not enter the bladder, the urine accumulated in the bladder will remain clear. Hence the same individual will pass a clear second urine if micturition is frequent, and a cloudy second urine if micturition is infrequent. These frequent changes from a clear second to a cloudy second urine are one of the most important characteristics of acute posterior urethritis, and an important differential sign between urethritis and cystitis, in which the mucus and pus which cloud the urine are produced in the bladder itself, and therefore a second clear urine is impossible.

If the posterior urethritis is very acute, the second urine is always cloudy; if it is subacute and the quantity of pus smaller, the urine will only be cloudy after prolonged retention.

Posterior urethritis also presents a tendency to nocturnal exacerbations. The prolonged retention of urine at night thus coincides with the greater production of pus, and individuals who, during the remission of the inflammation in the day time (when they also urinate more frequently) pass a clear second urine will present a distinct cloudiness of the second urine passed in the morning. Hence follows the important rule that posterior urethritis cannot be excluded unless the second portion of the first urine passed in the morning is clear.

The test of the two vessels, especially with the morning urine, will permit us to make a diagnosis even in cases of slow posterior urethritis, which begin without any symptoms.

In these cases the first portion of urine is always more cloudy than the second. The urine has been made cloudy in the bladder, but the first portion, in its passage through the urethra, carries with it all the pus found there. The second portion passes through the urethra after it has been cleansed of pus, and is therefore not rendered still more cloudy.

The degree of cloudiness of the second urine, since it depends upon the excess of pus produced in the pars posterior, is a gauge of the intensity of the inflammation.

In some cases posterior urethritis develops brusquely, and is characterized by a series of often very typical symptoms.

Among these the vesical tenesmus is the most striking,

and the most annoying to the patient, and its severity is proportionate to the degree of inflammation. In the most acute cases the tenesmus is constant and extremely distressing. It forces the patient to urinate every five to ten minutes. The amount of urine discharged is then very small, since too little time is given for the filling of the bladder. The micturition does not relieve the tenesmus, which continues whether the bladder is full or empty. It is entirely independent of the urine and is not produced by the irritation of the latter. In discussing the physiology of the subject, we stated that the normal desire to urinate is called forth by the stimulus exercised by the urine upon the pars prostatica. But this feeling can also be provoked by other means—for example, by the introduction of a bougie or catheter. This is also the case when violent inflammation irritates the pars prostatica.

The irritation of the inflamed mucous membrane of the pars prostatica then causes permanent desire to urinate, and hence its complete independence of the condition of fullness of the bladder. Every influence which intensifies the inflammation also increases the vesical tenesmus. It is therefore increased by rapid movement, especially driving and riding, and diminished by quiet.

The vesical tenesmus is more characteristic in subacute than in acute cases. If the patient has evacuated the bladder he feels no tenesmus so long as the organ is gradually filling. But after retention of urine for a few hours the desire to urinate, which can usually be overcome without difficulty by healthy individuals, becomes at once so imperative that the patient cannot restrain it, at the danger of involuntary micturition. The physiological desire to urinate is caused by the stimulus of the first drops of urine which, when the bladder is full, pass into the posterior portion of the pars prostatica. The desire is slight at first, and increases with the amount of urine entering the pars prostatica and the increasing pressure to which it is subjected.

If the mucous membrane of the pars prostatica is moderately inflamed, the stimulus of the inflammation will not produce spontaneous desire to urinate. But the first drops of urine which reach the inflamed mucous membrane will produce, instead of the physiological, an intense desire whose severity varies according to the degree of inflammation.

The more acute cases of posterior urethritis are usually accompanied by hæmaturia. In the milder cases of hæmaturia a few drops of blood only appear on pressing out the last drops of urine. This blood is squeezed out of the inflamed, perhaps eroded mucous membrane of the pars prostatica by the contractions of the sphincters of the bladder; it does not come from the bladder but from the pars posterior. This was proven by Horovitz (1885). When the last drops of urine were passed, in patients suffering from hæmaturia, he introduced an elastic catheter into the bladder, washed out the organ, and allowed the instrument to remain. The urine discharged from the bladder through this catheter was found to be free from blood, a clear proof that the hemorrhage is not situated in the bladder itself. When the hemorrhage is more severe the blood which flows from the pars posterior, enters the bladder with the pus and gives the urine a bloody color. The patient then passes urine which is bloody in both portions, and a few drops of blood are voided with the last drops of urine. As a matter of course violent tenesmus is always associated with this acute stage.

Subjective Symptoms.—Other subjective symptoms are almost always noticeable. The patients usually complain of burning, tickling, perhaps of slight lancinating pains in the deep portions of the urethra and towards the anus, which often increase after micturition and defecation.

Sexual Irritative Symptoms.—These vary according to the intensity of the process, and are analogous to those observed in acute anterior urethritis. Priapistic, painful erections are generally absent. The erections are painless but, on the other hand, pollutions are frequent and the moment of ejaculation is accompanied by a sticking pain in the deep portions of the urethra. The pollutions which are especially frequent in subacute posterior urethritis, and often occur several times a week, owe their development to the inflammatory irritation of the caput gallinaginis and are so characteristic that if a patient begins to complain of frequent pollutions in the third or fourth week of an urethritis, the physician should always examine concerning the existence of a posterior urethritis.

Secretion.—The secretion is analogous to that of anterior urethritis, *i.e.*, muco-purulent, the proportions varying ac-

cording to the acuteness of the inflammation. The more acute inflammations always produce more pus. The turbid urine in the two beakers will therefore deposit the same two layers, an upper mucous and a lower purulent layer, in varying proportions. Examination of the pus corpuscles of the urine in the second glass with alkaline methyl blue will always show a greater or smaller number of characteristic gonococci heaps.

On the other hand posterior urethritis is associated with a symptom peculiar to it, *viz.*, a not inconsiderable albuminuria. An amount of albumin is found in the filtered urine on boiling and on the addition of nitric acid, which is out of proportion to the pus. This albuminuria is intimately connected with the vesical tenesmus, increases and diminishes with the latter, and reappears on the reappearance of the tenesmus. The origin of this symptom is not fully explained. It is conceivable that, among the many reflex symptoms produced by acute inflammation of the pars prostatica, albuminuria also constitutes a reflex, vaso-motor disturbance. Ultzmann (1880) accepts Runeberg's theory. According to the latter writer albumin will filter from the glomeruli into the renal tubules of the healthy kidney, either when the arterial pressure in the glomeruli diminishes or the pressure in the tubules exceeds the secretory pressure, as happens in damming back of the urine in the ureter. Now the acute inflammation of the pars posterior and the violent tenesmus which it produces, give rise to reflex muscular spasms. Detrusor spasm also appears to occur and increases the tenesmus. Inasmuch as the ureters run transversely through the muscular fibres of the detrusor vesicæ, spasmodic contraction of the latter will compress the lowermost part of the ureters, give rise to damming back of the urine and thus to albuminuria. The latter will cease as soon as the reflex detrusor spasm subsides with the cessation of the tenesmus, and will return with the recurrence of the spasm.

General Symptoms.—These are similar to those of anterior urethritis, but are usually more intense. The acute form with its distressing tenesmus is accompanied by the most severe general symptoms. The tenesmus, although constant, is subject to spasmodic exacerbations whose intensity often causes the patients to cry out aloud and brings beads of per-

spiration to their brows. The general condition then is usually very much depressed, the sallow complexion and the rings around the eyes convey the impression of a serious disease. Fever is generally present. The appetite is usually lost, and there is often obstinate constipation.

In the subacute cases the general organism is not noticeably affected.

Forms.—According to the intensity of the process we distinguish three typical forms of the disease.

1. *Subacute Form.*—A predominantly catarrhal disease with production of an almost exclusively mucous secretion, which contains few pus cells. In many of these cases the second portion of the urine is only cloudy in the morning, but clear during the day. The subjective symptoms are confined to somewhat imperative, perhaps more frequent, desire to urinate.

2. *Acute Form.*—The secretion more purulent, its amount greater, so that the second portion of urine is almost always cloudy and is only clear occasionally during the afternoon, when the remission of the inflammatory process coincides with the more frequent micturition resulting from the meal. Subjective symptoms are more severe, especially more frequent and imperative tenesmus.

3. *Peracute Form.*—The secretion abundant and purulent, the second urine always very cloudy, tenesmus very violent, hæmaturia after micturition, subjective symptoms marked, general condition very much affected.

Course.—We have already said that acute posterior urethritis usually reaches its acme rapidly, and then takes a slow course before complete recovery. The stage of greatest intensity may become ominous from the fact that the inflammatory process may extend beyond the urethra to adjacent structures, the prostate, bladder, epididymes, and produce inflammation of these organs.

The slow course of the stage of recovery may be delayed still further by the fact that external injurious influences may induce relapses, and these may be followed by complications.

In like manner the frequent pollutions provoked by the process itself may cause notable prolongation of the acme of the inflammation, increase of the inflammatory symptoms and relapses.

With the long duration of the acute stage and the frequent relapses, recovery is made difficult and the development of chronic changes is favored.

Diagnosis and Differential Diagnosis.

If we have a patient suffering from a mucous, muco-purulent or purulent discharge from the urethra, two questions must be answered: 1. Is this discharge gonorrhœal? and 2. How far along the urethra does the gonorrhœal disease extend, particularly with regard to the compressor urethræ?

The first question is answered by the results of microscopical examination, and depends directly on the demonstration of gonococci in the pus or muco-pus. This question is so important, and attended with so much responsibility to the physician, that it necessitates careful examination. A single examination is often insufficient.

The number of gonococci in the purulent and muco-purulent secretion of florid blenorrhagic urethritis is usually considerable. If we have examined several, at least two to four, cover-glass preparations from an acute suppuration of the urethra and have not found gonococci, the negative results exclude blenorrhœa.

This is not true of the mucous secretions of the initial and terminal stages. In these the number of gonococci is small, particularly in the terminal stage. Accordingly, if we find no gonococci in several preparations, we should not exclude blenorrhœa, but should repeat the examinations later and also take the course of the disease into consideration. If the mucous secretion has only lasted a short time, it will soon be converted into a purulent secretion, in which the demonstration of gonococci is not difficult, and clears up the diagnosis. If we have to deal with the terminal stage, this must have been preceded by a purulent discharge, as will appear from the patient's statements. The process will then either subside spontaneously in a little while and thus make the question of its character unnecessary, or a relapse will occur with purulent secretion, in which the demonstration of gonococci is generally easy.

But in every case in which the diagnosis of blenorrhœa is made, the micro-organisms found by us must be fully proven

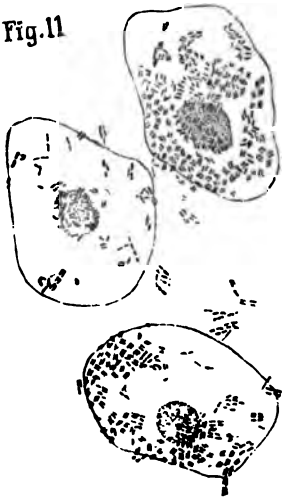
Plate IV.

Finger:

Fig.9

Fig.10

Fig.11



to be gonococci, and must possess a series of characteristics. The absence of even one of these makes the diagnosis doubtful. These characteristics are:

a. Shape.—We have already described gonococci, and will here merely call attention to their shape, which resembles that of coffee beans, and to the fact that, inasmuch as they are diplococci, they are always found joined in twos and twos, with their flat or slightly concave surfaces directed towards one another.

b. Grouping.—The mode of their division gives rise to the circumstance that the gonococci are never found in chains, however short, but always in heaps. Within these groups we usually find two cocci pairs closer to one another in sarcina shape. The number of single cocci (not in pairs) is always divisible by two, but usually also by four.

c. Staining.—Gonococci are readily stained by aniline colors, but they also lose their staining readily in comparison with the majority of other cocci. They are decolorized by treatment with alcohol, according to Gram's method, while this does not affect the staining of most other cocci. In order to demonstrate this, a cover-glass preparation is stained with gentian violet aniline-water, and examined under water, an attempt being made at the same time to determine the number of colonies which are regarded as gonococci. The preparation is now placed for one minute in a solution of potassium iodide (the separation of the cover glass from the slide is facilitated by the addition of a little water on one side), decolorized in alcohol, and again examined. If the groups previously regarded as gonococci are now invisible, while other, perhaps previously visible, cocci and bacteria are distinctly visible, we have another reason for regarding these groups as gonococci. (Roux, 1886.)

d. Position.—The heaps of cocci must always be found in the protoplasm of cells (pus and epithelial cells). This is proven by the fact that the cocci and the contour of the cell nucleus are equally distinct at the same focus, and that the cocci do not project beyond the edge of the protoplasm. The number of gonococci in one cell varies from one or two pairs to complete distention of the entire cell body, which often appears dilated. Very characteristic of cocci, also, is the finding of nuclei of pus cells, enclosed in heaps of gonococci, and

which no longer present a cell contour. The cocci pairs are then usually aggregated more closely towards the centre, more loosely towards the periphery of the mass. These masses are derived from the destruction of pus cells which have been filled with cocci.

e. Number.—If a purulent secretion is really blenorrhagic the number of gonococci heaps is always considerable, and the discovery of a few diplococci, even if situated in cells, is not convincing.

Lustgarten and Mannaberg (1887) have recently attacked the diagnostic significance of gonococci, in view of the discovery of diplococci also enclosed in cells, in the normal urethral mucous membrane. So far as concerns acute urethritis I must oppose their views (I will discuss at a later period the significance of gonococci in the diagnosis of chronic urethritis). For four years I have had the opportunity of examining, with regard to micro-organisms in the pus, every case of acute and chronic urethritis (and their number is not small) which came under my observation. There is no doubt that, in addition to gonococci, other micro-organisms are also found in blenorrhagic pus, but these never give rise to even the slightest diagnostic doubt. The number of foreign micro-organisms, especially cocci, is so slight, and they are found to such a large extent outside of cells (with few exceptions), and their shape and grouping are so different from those of gonococci, that the differences in staining (which were not tested by Lustgarten and Mannaberg) are unnecessary to make a positive differential diagnosis. The impression is never created that these cocci are due to more than accidental soiling, or that they increase in the pus. In fact the vital conditions in the normal and blenorrhagic urethra are so different that, without strict proof, we can hardly arrive at the conclusion that the micro-organisms of the normal urethra can be propagated in the blenorrhagic canal.

The direct proof that a urethral suppuration is blenorrhagic must be adduced, for the reason that there is also a series of other catarrhal affections of the urethra which present similar symptoms.

Thus, chemical and mechanical irritants, which act upon the urethra, produce symptoms which apparently are entirely like those of clap. These suppurations can be distinguished from those of blenorrhœa by two factors. In the first place,

incubation is wanting, the reaction follows the irritant influence at once, rapidly increases to its acme, and soon disappears. The suppuration is confined to the part of the mucous membrane which has been injured by the irritant, and presents no tendency to migration and peripheral spread, and no tendency to a protracted and chronic course.

Any one who has the opportunity of making injections of concentrated astringents into the urethra, may convince himself of this fact.

If a patient, suffering from chronic urethritis, receives an urethral injection of a two to ten per cent. solution of nitrate of silver, violent reaction occcurs at once, attended with violent, burning pain. Three or four hours after the injection, thick, creamy pus, like that of acute urethritis, is discharged, and the urine is very cloudy, but the entire reaction rapidly diminishes within twenty-four hours. The same observation may be made in those cases in which, usually by accident, caustic injections have been made into the healthy urethra.

The adherents of the theory which denies the existence of a blenorrhagic virus also deny the difference between clap and traumatic and chemical catarrhs, as regards incubation and course, and they oppose a thousand-fold experience with the single experiment made by Swediaur (1798).

This writer injected a solution of ammonia into his own urethra, and suffered in consequence from an urethritis which developed without incubation, extended in three exacerbations as far as the neck of the bladder, and lasted seven weeks. Entirely apart from the fact that this experiment confirms the difference, so far as regards incubation, between virulent and non-virulent blenorrhagia, it is time to control this experiment, which is a century old and performed under one knows not what conditions, by others made with proper precautions, or to allow it to rest, like Hunter's experiment, and to regard it as a mere historical curiosity.

Urethral catarrhs, usually of a mucous character, can also be produced by other irritants.

Thus, slight mucous or muco-purulent catarrhs, which rapidly heal spontaneously, develop after coitus with menstruating or leucorrhœic women. Microscopical examination of the secretion usually shows several diplococci and rod varieties, one of which (Plate IV., Fig. 10), in view of the con-

stancy of its occurrence in several cases, and its notable predominance over other rods and cocci, perhaps stands in a close causal relation to the affection. Gonococci were absent in these cases, despite the tolerably abundant suppuration and the careful examination of numerous preparations.

But purulent urethral catarrhs with a mild course also appear to be produced by other pathogenic micro-organisms than gonococci. Aubert (1884) reports three cases of urethritis, in which he found one and the same form of coccus; one case was followed by epididymitis and cystitis. Bockhart (1886) reports fifteen cases of infection—among these were ten married men—produced by vaginal secretion, which was followed by mild muco-purulent catarrh; in two cases alone did it extend to the pars posterior and epididymis. As the cause, Bockhart found extremely small cocci, analogous to gonococci; he made pure cultures and performed two inoculations with positive results. In two other cases evident streptococci were found.

Mild muco-purulent catarrhs of the urethra with slight secretion, which are manifested merely by agglutination of the meatus and a few flakes in the urine, may occur as symptoms of syphilis. Lee, Vidal and Hammond discuss this affection, but the most detailed description was furnished by Tarnowsky (1872). They consist in the formation of superficial erythematous or papular efflorescences on the mucous membrane of the urethra, which occur as a part of a general secondary syphilis or alone as a relapse of the secondary syphilide. These erythematous or papular ulcerations secrete the small amount of catarrhal or, though rarely, purulent secretion, which appears at the meatus and simulates blenorrhœa. Examination of the patient, the demonstration of recent syphilitic symptoms or their residua, the previous history and the results of antisyphilitic treatment prove the diagnosis of syphilitic as distinguished from blenorrhagic urethritis.

Finally, attention must be called to still another affection. Diday (1860) first directed special attention to patients who complain of obstinate urethritis and constantly express a drop of pus from the meatus. If we examine carefully it is found that this pus does not come from the meatus, but from small openings on the inner surface of the lips of the meatus. In this locality are found glands, whose short excretory ducts empty on the inner surface of the lips of the urethra. Puru-

lent catarrh of these glands often occurs independently, perhaps also as the result of blenorrhœa, and can only be cured by destroying them with hot needles.

The similarities between soft and hard chancre at the orifice and blenorrhœa are so remote, and the differences usually so distinct, that it is sufficient to mention them as possible causes of error.

The second question presented refers to the extent of the process, *i.e.*, whether we have to deal with an urethritis anterior or posterior. This question is answered in every case by the test of the two beakers. A first cloudy urine and a second clear urine indicates a simple anterior urethritis; a second cloudy urine means posterior urethritis. But even in posterior urethritis the second urine may be clear occasionally, and it is therefore advisable to make several examinations. The morning urine is especially decisive, in the first place because the patient has not urinated for the longest time, and then because the morning exacerbation coincides with the retention of urine for several hours. I can recommend as very practical and easily carried out a method which I have employed for several years with good results. The patient is directed to bring at each visit the morning urine divided into two portions, and also to retain the urine in the bladder for several hours before the visit. If he then passes the urine into two vessels, and this plan is carried out from the beginning of the blenorrhagic stage, we are always kept accurately informed concerning the extent of the process.

Every reader of these lines and every observer will have been struck by the great similarity between posterior urethritis and cystitis. A few distinctions between the two diseases have been already noted; the differential diagnosis will be discussed in the consideration of cystitis.

Prognosis.

Simple and uncomplicated blenorrhœa, whether situated in the pars anterior or posterior, is a harmless affection in the large majority of cases. The prognosis as regards duration is not so good. Here Ricord's dictum holds true: "Une chaude pisse commence, Dieu le sait quand elle finira."

The causes of its transition into a chronic condition are in-

numerable, and such an event is connected with so many circumstances which are independent of the physician, and in part of the patient, that the former should be very reserved in making a prognosis. Urethritis with short incubation and quite rapid onset has a more favorable prognosis as regards rapid termination than the subacute forms, in which the incubation lasts longer, and the process slowly reaches a mild acme. For this reason, also, the prognosis as to duration is more favorable in the first infection than in repeated infections, which generally run a subacute course.

Caution in prognosis is therefore necessary, because the process becomes aggravated with its duration, and also because of the various sequelæ and complications.

A series of complications may even give rise to symptoms which threaten the life of the patient.

Even a simple uncomplicated blenorrhœa may cause serious, dangerous symptoms on account of the intensity of the inflammatory phenomena. We have mentioned a few of these fatal cases in describing chordee.

Apart from this complication an acute urethritis may terminate fatally when the inflammatory symptoms become very acute *per se*, or as the result of external irritants, or of especially unfavorable dietetic and hygienic influences.

Gervais (1866) mentions three cases in which dangerous hemorrhages from the urethra were caused by coitus in the acute stage of urethritis. In Paul's case (1875) excesses in the diminishing stage of an acute clap were followed by hemorrhage from the pendulous portion. An obstinate stricture developed at the point of rupture.

Even without external influences urethritis may give rise, though rarely, to extremely dangerous symptoms. Jenensky (1882) reports the following case: A peasant, æt. twenty-three years, who had coitus for the last time a week before, was admitted on September 8, 1882, to the Rochus Hospital in Pesth, suffering from an urethritis of five days' standing. On admission the entire penis was found swollen, cold, and the integument bluish green. The swollen glans was partly covered by the œdematous prepuce; abundant purulent discharge from the urethra. Scarification of the integument of the penis was performed. The wounds, whose edges rapidly assumed a bluish-green color, discharged nasty green pus. Gangrene developed

in the skin of the prepuce and penis, which exfoliated and healed with production of cicatrices.

The prognosis also depends materially upon the conduct of the patient. This furnishes an important reason for caution, even in simple cases, and for calling the attention of the patient to the possible dangers of an imprudence.

Anatomy.

Like the obscure etiological views on blenorrhœa, the notions concerning its nature and situation were also very obscure. The imperfect opportunities for making autopsies were an important factor in producing this state of affairs.

The oldest appellation of the disease *viz.*, gonorrhœa (flow of semen, from γονη, seed, and ῥέω, to flow), showed that the ancients identified the secretion of blenorrhœa with semen. But this opinion was not accepted universally, and, as we have seen, the nature of the secretion as pus was soon recognized and the process regarded as inflammatory. From this period the disease was regarded as much more serious than it really is. There was talk of ulcerations of the urethra. The views concerning the nature of the discharge also varied, and these uncertainties and essentially different opinions persisted until the middle of the eighteenth century.

Thus, Sydenham (1680) regarded clap as an inflammation of the spongy substance of the penis, which gradually passes into suppuration. The pus is then deposited in the urethra and slowly escapes, as is seen in clap and spermatorrhœa. Zeller (1700), Warren (1710), Lillie (1711), Astruc (1754) place the site of clap in Cowper's glands, the prostate, and seminal vesicles, and attribute it to suppuration and ulceration of these glands. This opinion is explained by the fact that the few autopsies made by these writers were performed on individuals suffering from old, neglected clap, accompanied by strictures and severe retro-strictural changes and ulcerations. The observations made in these cases were then generalized.

The few writers who, favored by fortune, had the opportunity of examining recent urethritides post-mortem, soon adopted another view. Thus, Laurentius Terraneus (1703) had the opportunity of making six autopsies on recent cases, in one of which, urethra omnino inflammatione livescebat, glandulæ-

que disgregatæ immodicum extremebant. Terraneus therefore explains blenorrhœa as an inflammation of the entire mucous membrane, whose surface produces the discharge. Cockburne (1717) expressed the same opinion soon afterwards.

But the view that there were severe ulcerative changes in the urethra still remained the prevailing one. This descended to Morgagni, who, in 1745, introduced his divergent views in the following words: Etsi pauci forte sint Anatomici a quibus tot fuerint, quod a me, urethral viriles dissecatæ, et diligenter perlustratæ; tamen aut rarius quam vulgo existimant, luculentiora in eo canali vitia occurrunt quæ contagiosam Gonorrhœam comitentur, aut nescio quo casu factum est, ut cum magnus hominum hac infectorum sit numerus, illa ego vitia tam luculenta vix unquam aut ne vix quidem conspexerim. Morgagni then passes to the description of his findings, which included merely slight redness, increased moisture of the urethral mucous membrane, but complete intactness, or at least no severe ulcerations, in the urethra, prostate or seminal vesicles. It is also an interesting observation of Morgagni (which was corroborated one hundred years later by Virchow) that the pus corpuscles of clap are larger than those found in other forms of pus, but Morgagni could not make up his mind to call the discharge of clap true pus, and adopted Rondelet's term materia puriformis.

In 1753 Hunter had the opportunity of examining two hanged criminals who had been suffering from clap. In neither did he find ulcerations of the urethra, but the mucous membrane, especially within the glans, was very much reddened. In subsequent autopsies Hunter found a similar condition of the urethra.

In 1777 Stoll had the opportunity of examining the genitalia post-mortem. Greenish pus escaped from the urethra, and the meatus appeared reddened. The mucous membrane of the urethra was swollen for two fingers' breadths from the meatus and also in the bulb; in the place of Morgagni's lacunæ were found a large number of whitish specks and dots.

Gendrin (quoted by Gibert, 1836) describes the following findings: a soldier, vigorous and robust, suffered, in consequence of neglect of a blenorrhœa of ten days' standing, from retention of urine and fever. The catheter discharged foul-smelling urine. Fatal termination after severe general symp-

toms. The autopsy showed swelling of the walls of the bladder and several ulcerations in its mucous membrane. The vesical peritoneum was inflamed. The entire urethral mucous membrane had a livid color and was swollen; in the bulb an ulcer as large as a 50 centime piece involved the entire circumference of the canal, and there were two others, with a diameter of about two lines, one in the middle of the pendulous portion, a second next to the prostate.

Lisfranc (1815) states that he made many autopsies on individuals suffering from blenorrhœa and who had died of adynamic fever. He claimed to have found ulcerations of the diseased mucous membrane quite frequently. According to his investigations the disease begins in the fossa navicularis, extends about the twelfth day to the bulb, and about the twentieth day to the membranous portion.

Cullerier secured only one autopsy on a case of acute urethritis in twenty years, and found two markedly injected patches in the region of the fossa navicularis and pars membranacea, which were connected with one another by stripes of inflammatory redness.

Boyer (1836) found, in one case, merely inflammatory redness of the pendulous portion.

Friedberg (1865) describes the following appearances at the autopsy of a boy of sixteen years, who had suffered from clap for four weeks, and died as the result of an injury to the head. The urethra contained quite consistent, greenish-yellow, purulent secretion. The mucous membrane was moderately swollen in the fossa navicularis and of a dull, dark-red color. Much more vivid injection was found in the pendulous portion of the urethra and extended about 2″ into the pars prostatica. The posterior wall of the pars membranacea projected distinctly and narrowed the lumen of the canal in a striking degree. The projection was caused by an extravasation of blood, which apparently started from the very vascular cellular tissue surrounding the mucous membrane, inasmuch as the hemorrhage lay not alone between the mucous membrane and the connective-tissue envelope, but also between the latter and the circular muscular stratum of the urethra. An extensive ulcer was situated here on the posterior wall of the mucous membrane, and its soft, here and there eroded edges ran an irregular course and remained at the level of surrounding parts. The

ulcer was covered by laudable pus, which could be readily washed off. The base of the ulcer showed partly necrotic, partly granulating tissue. In the immediate vicinity of the edges it only included the surface of the mucous membrane, while it involved the deeper layers toward the centre. A few of Littré's glands were distinctly swollen on the left side of the upper border of the ulcer. Cowper's gland on the right side was swollen to the size of a large pea and contained a yellow, tough, consistent, muco-purulent secretion. The opening of the gland lay in the ulcer and was occluded by a firm clot; the inner wall of the gland was strongly injected.

Voillemier (1868) had the opportunity, in the course of thirteen years, of attending nine autopsies on individuals suffering from blenorrhœa, and gave accurate reports. The fifth case is the most interesting. A young man, æt. twenty-four years, died from a railway injury, while suffering from a first attack of urethritis of nine days' standing. The urethral mucous membrane appeared somewhat contracted. It was swollen and reddened over a surface extending 7 cm. from the orifice, the openings of Morgagni's lacunæ were distinctly visible and the mucous membrane thus appeared as if strewn with fine openings. In the median line of the canal, 4 cm. from the meatus, a lacuna Morgagni was depressed, the surrounding parts destitute of epithelium, and as a result a superficial ulcer, 3 mm. long, 2 mm. broad, had formed. On compression of the mucous membrane greenish-yellow pus escaped from the openings of Morgagni's lacunæ.

A. Guérin (1854) reports the following autopsy: the penis was enlarged and œdematous, the swollen prepuce covered the glans, and abundant creamy pus could be expressed from the urethra. The mucous membrane is moderately reddened, Morgagni's follicles distended, and pus could be squeezed out of the latter. On section of several follicles they were found dilated into sacs, which extended almost 1 cm. into the urethral walls. The tissue of the bulb is filled with blood, the meshes near the mucous membrane contain clots similar to those found in veins. The trabeculæ are soft and yielding.

Murchison (1875) describes a case in which the patient died of blenorrhagic cystitis and nephritis, and the autopsy showed redness and swelling of the entire urethral mucous membrane.

In order to complete the anatomo-pathological history of

acute urethritis, we will here describe the endoscopic appearances.

Desormeaux (1865) describes acute blenorrhœa as intense redness and swelling of the urethral mucous membrane, whose surface is uneven and covered with erosions. When the process is about a week old, it extends to the middle of the pars pendula. When it becomes older, the anterior parts resume the normal appearance while the deeper parts become affected.

Gruenfeld (1877) described the urethral mucous membrane as swollen, ridged, of a dark-red to bluish-red color, the surface smooth and superficial epithelial losses noticeable here and there. The mucous membrane bleeds readily on contact.

We will now make a *resumé* of the picture of acute urethritis resulting from these examinations.

It constitutes an inflammation of the mucous membrane and submucous tissue with all its characteristics, such as redness and swelling and secretion of a mucous, muco-purulent or purulent discharge. The intensity of the inflammation will vary, and hence the mucous membrane presents different appearances. Sometimes the swelling will be slight and the injection dendritic, sometimes the redness and swelling will be very marked. The glands and follicles always appear to be affected early and intensely. They become swollen, their openings gape in the shape of a funnel. The inflammation also extends to the lumen of the glands, and even the parenchyma takes part in the inflammation and the production of morbid secretion. If the lumen of the gland or follicle is now occluded by a firm plug of mucus or pus, retention of pus and the formation of cysts result, as in Guérin's case. Desquamation of the epithelium and superficial losses of substance also take place at the mouth of the follicle, and if the process is severe may lead to small ulcerations (clap ulcers). Deeper ulcers may also develop, perhaps, from the rupture of one or more cysts due to occlusion of the gland openings. This early and intense implication of the glands explains the obstinacy of clap and its tendency to relapse. The latter is due to the persistence of the process, which has died out on the surface, in one or more glands, where the virus increases and may then be discharged upon the surface; perhaps because the secretion of the virus is increased by local and general irritating influences, such as coitus and excesses in Baccho.

The corpus cavernosum is also implicated in the more severe cases, its trabeculæ are swollen and more succulent, the erectile tissue is richer in blood, its meshes plugged by clots of fibrin in parts of the peripheral layers.

Rokitansky makes the following statements concerning blenorrhagia: The catarrhal inflammation of the urethral mucous membrane as clap has a tendency to run a chronic course. It is either distributed quite uniformly over the urethra or it is very often confined to one or more places, either originally or in its subsequent course. Such spots are found everywhere up to the pars prostatica, but most frequently near the bulb and in the fossa navicularis. They are manifested by dark redness and swelling, occasionally (particularly in the fossa navicularis) by striking swelling of the mucous glands and formation of pus. The corpus spongiosum at these places (mainly in the inner layers, but sometimes in its entire thickness) is swollen, the size of its meshes is diminished, and it therefore contains less blood. This gives rise to a resisting ridge which is visible in the urethra.

Although we are well informed concerning the macroscopical changes in blenorrhœa, we know hardly anything of the finer microscopical changes, particularly concerning the situation and distribution of the gonococci.

Jullien (1886) adopted the unproven theory that the blenorrhagic process occurs chiefly in the lymph channels; he divided mucous membranes into those which are susceptible to blenorrhœa (with pavement epithelium, no papillæ and a high network of sub-epithelial lymphatics), and those which are not susceptible (with cylindrical epithelium and a high vascular network).

Bockhart's (1883) previously mentioned case has not alone been the subject of attack with regard to its etiology, but the histological appearances also present certain peculiarities. Thus, the statement that the gonococci were situated in the nuclei of the migratory cells is entirely opposed to what is seen in blenorrhagic pus; and the pictures and descriptions of transverse sections of lymphatics filled with heaps of gonococci are so similar to Ehrlich's mast cells, that we must think of a mistake between the two, especially as no mention is made of mast cells, which are hardly ever absent in a specific inflammation.

A partial substitute for the lacking histological details of blenorrhœa urethræ is afforded by Bumm's (1886) investigations on blenorrhœa conjunctivæ neonatorum.

According to Bumm the process in blenorrhagia, the combat between gonococci and the inflammatory products which endeavor to eliminate them, occurs in the following way: The infecting secretion conveys a certain number of gonococci to the mucous membrane. These penetrate the layer of epithelial cells and reach the papillary body of the mucous membrane, passing through and between the protoplasm and cement substance of the epithelial elements. Swarms of white blood globules emigrate at this time from the dilated capillary network which extends almost to the epithelial covering, and penetrate into the upper strata of the connective tissue, whence, laden with gonococci, they pass through the epithelium to the surface. The epithelial stratum, whose firmness is destroyed by the proliferation of cocci, is fissured by the stream of fluid accompanying them, and raised in clumps; this may be aided by capillary hemorrhages between the epithelium and cellular tissue.

The distribution of the cocci is confined to the superficial layers of the sub-epithelial cellular tissue, where they are arranged between the fibres in rows or round colonies. While the micro-organisms increase in this manner in the outermost layers of the connective tissue, the inflammatory symptoms increase in intensity, and the round-cell infiltration finally occupies the entire papillary body, cell being closely applied to cell. This furnishes the transition to the purulent stage, in which the majority of the gonococci are washed away by the abundant suppuration. After a variable time regeneration begins from the remains of the original epithelium, and by its extension puts an end to the further spread of the cocci in the tissues, while the migration of the pus cells, which carry off the remainder of the cocci, proceeds uninterruptedly. With the regeneration of the epithelium are usually associated proliferating processes, from the lowermost layers of which epithelial papillæ grow into the connective tissue substratum. At this time the cocci have disappeared, with the aid of the pus cells, from the papillary bodies, and are only found in the upper layers of the epithelial covering. But if the fresh epithelial covering cannot withstand an irruption of migrating

round cells, induced by external irritants, its continuity will suffer and a new invasion of the papillary body with cocci will take place, *i.e.*, a relapse occurs. During the latter part of the purulent stage and the entire muco-purulent stage the proliferation of gonococci takes place outside of the tissues, upon the surface of the epithelium and in the secretion.

Treatment.

There is hardly a branch of medicine which is so rich and in which so many and opposing recommendations, remedies and methods have been employed, as in the treatment of clap. Nevertheless, perhaps on account of this very fact, the treatment of the disease is one of the most thankless tasks in medicine.

Not alone do external social conditions, the necessity for concealment, often impair the therapeutic results, and make the hygienic-dietetic prescriptions illusory, but the struggle with the patient which the physician must undertake in order to keep the most powerful of all senses, the sexual sense, within the bounds necessary for recovery—a battle in which the physician often succumbs—and the routine manner of treatment, are in great part at fault in the numerous bad results. So long as no change occurs in these respects, progress cannot be expected, and in addition to the complications a large percentage of chronic urethritides must be attributed to the fault of the physician. So long as the physician regards every drop of pus at the meatus as synonymous with blenorrhœa and at once orders one of the usual injections with a clap syringe in a "purely reflex" manner, so long will the cure of blenorrhœa remain an accident, which occurs despite the physician and not on account of his treatment. Thanks to the profession the matter has gone so far that many patients who suffer from urethritis visit the nearest apothecary in order to buy a solution of zinc for injection, because they know that the physician will order nothing else.

A positive diagnosis, accurate localization, gauging of the intensity of the symptoms and then precise directions according to certain indications are the only methods of effecting sure curative results.

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We have already said all that is necessary in regard to

diagnosis. But I would like to emphasize the remark that, before beginning treatment, the conscientious physician should convince himself of the nature of the disease and examine for gonococci.

The second important question is the extent of the inflammation, whether we have to deal with simple anterior urethritis or whether this is complicated with posterior urethritis, inasmuch as the treatment is essentially different in the two cases.

Our anatomical studies have shown that the firm contraction of the compressor urethræ will make it impossible for fluids to pass from the pars anterior to the pars posterior. The ordinary method of injection with a clap syringe therefore carries the fluid into the pars anterior alone, and is useless in the treatment of posterior urethritis.

Indeed, these injections are positively injurious in posterior urethritis. It is well known that, when urethritis is complicated by cystitis, epididymitis, prostatitis, even a very mild astringent injection into the urethra increases the intensity of the complicating inflammation. But posterior urethritis is merely a complication of anterior urethritis and will also be aggravated by such treatment. Every physician who favors the routine treatment of every urethral suppuration with mild injections, will remember cases in practice in which the first injection was followed by some complication, usually epididymitis. Milton (1876) called special attention to this circumstance. Bad syringes, awkwardness in making the injection, carelessness of the apothecary in making the fluid stronger than ordered, these are the reasons given by the physician to the patient in explanation of the mishap. But probably the patient is right in attributing the exacerbation to the physician, inasmuch as a careful examination would have prevented the failure to recognize the posterior urethritis, which was intensified by the improper injection.

The acuteness of the process must also be considered in every case. But localization is also important in this respect because, if a complicating posterior urethritis is present, we know that we have to deal with two processes of unequal acuteness, and that those topical remedies which will diminish the inflammation if the latter is moderate, will increase it, on the other hand, if the inflammation is intense.

We will first consider the possibility and methods of preventing blenorrhagic infection, then the hygiene and diet of the patients, the individual anti-blenorrhagics, and finally the methods and indications for their employment.

Prophylaxis.—As a matter of course, the surest prophylactic measure against blenorrhagic infection is to avoid exposure. The small statistics furnished in considering infection show in which cases the danger of infection is greatest. But our social conditions make extra-marital coitus necessary for a large number of young people, and the question thus arises whether there is any means of preventing infection despite exposure. We have previously mentioned the factors which favor infection, and their avoidance alone constitutes a form of prophylaxis. In suspicious cases coitus should be performed rapidly, without previous protracted excitement, and repetition of the act should be avoided. This does not prevent infection absolutely, because the introduction of the virus is still possible. Measures were therefore sought which would destroy the virus adherent to the glans or that had penetrated into the urethra. One of the oldest and most rational, *viz.*, urination after coitus and washing of the glans with urine, was recommended by Johann de Gaddesden, Fallopius, Palmarius and Harrison. Guillelmus de Saliceto, Lanfrancus and Almenar mention washes of wine or vinegar. Torella thought the most certain means was the suction of the virus by other individuals. Magnardus recommended orange-blossom water for the rich, water in which iron had been cooled for the poor. Brassavolus and Boerhave suggested simple washes of cold water. Hieronymus Montuus recommends that a freshly killed hen or frog be cut in two and applied to the penis. Ertmueller advised washes of turpentine and wine. Cataneus, Falk, Preval, Hunter and Spangenberg recommended corrosive sublimate and gray ointment. Warren, Peyrilhe, Oesterlen mention alkaline washes and injections, and Hausmann (1886) has recently advised injections of a two per cent. solution of nitrate of silver.

All these chemical agents are uncertain, because it is doubtful whether they can kill the virus or whether they even come in contact with it. Mechanical means are, therefore, more certain and useful. Condom, an Englishman, prepared covers, made of the cæcum of lambs, and rubbed with bran and almond oil, which were drawn over the penis during coitus. The in-

Fig.12.

ventor, who is said to have lived in England in the time of Charles II., obtained little honor from his discovery. He was so universally scorned and ridiculed that he was forced to change his name. But the covers devised by him have transmitted his name to a grateful posterity and are in general use at the present time under the name of condoms. When impermeable and uninjured during coitus they furnish a greater safeguard than all chemical prophylactic measures. Unfortunately they are abused, and infection has been known to occur from previously used and insufficiently cleaned condoms, which were resold by prostitutes or dealers.

Hygiene, Diet.—After blenorrhœa has developed, the physician has two objects in view—to keep at a distance all factors which affect the course of the disease unfavorably, and to adopt curative and palliative measures.

The first object is attained by regulation of the hygienic and dietetic conditions.

This should not be regarded as trivial. In many cases, particularly in a first attack of anterior urethritis, strict regulation of these conditions would suffice to secure a rapid and favorable termination, as we can convince ourselves, particularly in hospital patients. Unfortunately not many patients, and least of all those in the better classes, are able to carry out such instructions strictly. For example, rest in bed can hardly ever be secured. At all events all forced movements, such as running, gymnastics, dancing, exhausting and long-continued walks, should be prohibited. All violent passive movements, such as riding, driving, particularly on bad roads or in heavy wagons without springs, are equally injurious. Travelling on the railroad, with its slighter oscillating movements, is less harmful. In all cases we should recommend the wearing of a good suspensory. This is intended to elevate the external genitals, penis and scrotum without exerting pressure on them, to fix them against the lower part of the abdomen, and thus prevent the shaking which increases the inflammation. The number of suspensories is very great. All are serviceable which exercise uniform pressure and traction, *i.e.*, those which not alone raise the external genitals, but also draw them against the body, the former by traction against the waist-band, the latter by traction against the perineum (Fig. 4). A good suspensory therefore possesses a waist-band, and perineal

or thigh straps, as in those of Kohn, Neisser (Fig. 5), Ihle (Fig. 6), Unna (Fig. 7). Those are bad which, like ordinary riding suspensories, simply raise the genitals, but leave this in the hands of the patient. By drawing too strongly on the straps the genitals are raised too far, and permanent compression of

FIG. 4.

FIG. 5.

the perineal portion of the urethra results. This irritates the canal and is apt to cause stasis of the secretion.

That coitus is to be forbidden is clear to the physician, but not always to the patient. Sexual excitement, resulting from lascivious thoughts, pictures, books, plays, and exciting female

FIG. 6.

FIG. 7.

society, are also to be avoided. But the abstinence and the increased sexual irritability due to the blenorrhœa produce great sexual excitement despite the will of the patient. This is manifested by frequent erections and pollutions, which are extremely injurious. This should be combated by a cool, hard bed, regular evacuations from the bowels, and the use of antaphrodisiacs. Camphor, lupulin, potassium bromide and

sodium bromide are useful. Camphor is also recommended externally, strewn upon cotton in the suspensory. The internal administration is preferable.

℞ Camphoræ rasæ, ... gr. iij.
Mixt. gummosæ, ... ℥ iij.
S. 1 teaspoonful every 2 hours.

Lupulin and the bromides are always given internally. We prescribe the following:

℞ Lupulini pur., ... gr. xv.
Sacch. alb., ... gr. xxx.
Mf. pulv. div. in dos. x.
S. 3 powders daily.

℞ Lupulini pur., ... gr. xv.
Morphiæ muriat., ... gr. ¾.
Sacch. alb., ... gr. xxx.
Mf. pulv. div. in dos. x.
S. 3 powders daily.

℞ Lupulini, ... gr. xv.
Camphoræ, ... gr. iss.
Extr. lupuli q. s. f. pill. x.
S. 6 pills daily.

The bromides are given morning and evening in gr. xv.–xxx. doses, but the following prescription is the most useful.

R. Natri. bromat., ... ʒ iiss.–iv.
Camphor ras.,
Lupulin, ... āā gr. vij.–xxij.
Mf. pulv. div. in dos. x.
Put in waxed papers.
S. 1 powder morning and evening.

Attention must also be paid to diet. Everything is to be avoided that makes digestion slow, causes constipation, irritates the genitalia directly and increases the inflammation.

As regards the first point, all articles heavy of digestion, such as puddings, rice, cheese, are to be avoided. Food seasoned with pepper, and curry, asparagus, highly salted and acid articles are stimulating and exciting. Very hearty, nutritious food acts the same way.

The fluids require special consideration. The close relationship of Venus and Bacchus is known not only in mythology. Carbonated drinks are especially to be avoided (champagne, beer, acid waters, such as soda water, Selters, Preblauer, Geisshuebler, etc.). This is also true of heavy Italian, Spanish and English wines. It is best to forbid all alcoholic drinks. In many patients this command is shipwrecked on the cliff of secrecy. Now, I have always observed that after prolonged and complete abstinence even small amounts of alcohol are injurious, but that the bad effects are slight if the patient from the start accustoms his clap, I might say, to a moderate amount of alcohol and does not exceed this quantity. I therefore allow my patients from the beginning to take daily the same amount of light red wine.

Many patients ask us concerning smoking. Bumstead (1883) regards it as injurious. It is true that those unaccustomed to smoking are sexually excited by it, but this is not true of habitual smokers. I therefore believe that it should not be absolutely interdicted.

The attention of every patient should be called to the danger of conveying the clap secretion to the eyes. Great care and cleanliness are indicated. It is best to allow him to wear some cotton in the præputial sac, which absorbs the discharge, and prevents soiling of the clothes; this should be frequently changed. Or the patient wears, attached to his suspensory and over the penis, a little bag which receives the discharge. Washing the hands after every manipulation of the genitals is strictly necessary.

These are, in brief, the hygienic and dietetic rules, which the physician must adapt to each individual case. Thus, if there is deficiency rather than excess of sexual excitement, sedative treatment must be abandoned, in weak individuals tonic treatment is indicated, and the withdrawal of nourishing, easily digested food is out of place.

Oversight of the Remedies.

The most ancient theory concerning clap was that we had to deal with the secretion of increased and spoiled semen. Hence remedies were prescribed which were supposed to diminish the production of semen, such as semen et folia rutæ, nux pineæ, semen anethi, lactuca, semina cannabis, plantago, origanum, etc.

The conviction (which soon gained sway) that clap was an inflammatory process, and the discharge the result of ulceration of the urethra and bladder, led to topical treatment, sometimes to the most fantastic recommendations. Sedative and cooling remedies, such as milk, whey, barley water, honey, and diluted vinegar, were used for injections. Very peculiar measures also appeared. Thus, we read in Hercules Saxonis (1597): "Sciendum autem est, quod habui a quibusdam Venetis; dicunt, se a gonorrhœa statim curatos usu Veneris cum muliere Æthiope. Haec quoque scio, antiqua gonorrhœa plenes fuisse liberatos, qui cum uxore, virgine rem habuere, sed tunc mulier inficitur." In the Richard manuscript of the thirteenth century discovered by Littré we read "Et nota, quod in magno dolore et tumore prodest, si in muliere diu, quando in coitu, moretur; vulva emin sugendo, mollificando et quasi purgando dolorem minuit et saniem attrahit."

When the theory of the syphilitic nature of clap was promulgated in the second half of the sixteenth century, it was subjected to antisyphilitic treatment, mercury, guaiac, sarsaparilla in large doses and drastic purgatives.

The change in the etiological views at the beginning of this century caused a change in treatment, and clap, recognized as a local disease, was treated locally. Some of the remedies were empirical, others, like the astringents, belonged to the group of antiphlogistics.

Advances in therapeutics might have been expected from the most recent investigations in etiology, especially from the discovery of the gonococcus. Unfortunately these expectations were not fulfilled. A few writers have made pure cultures of the gonococcus, and studied the effect of various remedies on contagiousness, growth and vital conditions, but these laborious investigations have hitherto had no practical value. These investigations do not always show clearly that the writers really experimented with the gonococcus, and then the growth of the cocci upon our artificial nutrient medium is so precarious and easily disturbed, that we cannot infer that those doses and remedies which prevent the growth of the pure culture, will have a similar or approximately similar effect upon the development on the good soil of the urethral mucous membrane. Until we possess an artificial nutrient medium which offers the gonococci the same favorable conditions as the ure-

thral mucous membrane, we can arrive at no conclusion on this question. But it cannot be held that the discovery of the gonococci has been entirely valueless as regards treatment. They furnish us with positive knowledge concerning two therapeutically important data—the diagnosis and the virulence of the secretion, the duration of treatment.

Corresponding to the local nature of the process, all our remedies are local, and differ only in so far as the topical action is effected, in one group, indirectly by internal administration, directly, in the other, by topical application. The internal remedies belong to the category of balsams and ethereal oils, or they are alkaloids, or finally mineral substances, particularly alkalies.

The ethereal oils and balsams occupy the most prominent place. This is particularly true of copaiba balsam, derived from various leguminosæ of the species copaifera, particularly copaifera officinalis and guyanensis. It forms a thick, light to brownish yellow, clear, sticky mass like thickened oil, with a peculiar resinous odor and a bad taste. It was first given internally by Markgraf and Pison (1648) and introduced into the treatment of venereal diseases by Daniel Turner (1729) and J. Thorn (1827). It is given in doses of 15 to 20 drops on sugar. Unfortunately the nauseous taste is then very pronounced, and the attempt was therefore made to conceal this or to give it in another form. From the desire to conceal the bad taste sprang Chopart's potion, which is still used in France:

℞ Balsami copaivæ,
Spir. vin. rectific.,
Syr. tolutan.,
Aq. menthæ,
Aq. naphæ, ... āā ℥ ij.
Spirit nitric, ... ʒ ij.
S. 3 to 6 tablespoonfuls daily.

Ricord modified and simplified this prescription:

℞ Balsami copaivæ,
Syr. diacodii,
Syr. tolutan., ... āā ℥ j.
Aq. menthæ, ... ℥ ij.
Aq. naphæ, ... ʒ iiss.
Gummi arabic q. s. f. emulsion
S. 3 to 9 tablespoonfuls daily.

The following similar mixtures are used frequently:

℞ Bals. copaiv., ... ℥ j.
Spirit. nitric., ... ʒ ij.
Tinct. opii spl., ... gtt xxx.
S. 20 drops 2 to 4 times daily.

℞ Bals. copaiv., ... ʒ iij.
Vitell. ovi tria c. aq. fontis, ... ℥ v.
Aq. cinnamon., ... ℥ j.
Syr. cinnamon., ... ℥ ss.
S. 1 tablespoonful every 3 hours.

The bad taste of these mixtures induced Lagneau and Velpeau to administer the balsam in enemata.

℞ Bals. copaiv., ... ℥ ss.
Vitelli ovi I.
Extr. opii aq. . . . . gtt. j.
Decoct. sem. lini. . . . . ℥ vj.
S. For one enema.

Wehner prescribed the remedy in suppositories:

℞ Bals. copaiv., ... ℥ v.
Pulv. opii, ... gr. iv.
Butyr. cacao,
Spermaceti, ... āā ℥ iss.
Ceræ alb., ... gr. xlv.
F. supposit. No. xii.
S. One suppository morning and evening.

All these, in part impracticable, methods of administration, became superfluous when Favrot and Mothe began the use of gelatine capsules, filled with 5 to 10 drops of the balsam, permitting its entrance into the stomach without its nauseating effect. The copaiba is given in this way at the present time, 3 to 6 capsules being taken daily.

Ricord (1849) and Roquelle (1854) showed that it merely acts locally, by passing into the urine. The latter, saturated with the balsam or its disassimilative products, passes through the urethra, and thus produces its action. Both these writers treated clap patients who suffered from urethral fistula, with copaiba internally. The portion of the urethra situated behind the fistula, and which was constantly washed by the urine, recovered, the portion in front of the fistula remained blenor-

rhagic and did not heal until injections of the patient's urine were made into it. Ricord then administered copaiba to a patient in his clinic who was not suffering from blenorrhœa, and injected a few clap patients with his urine. This urine proved effective, a distinct evidence of the topical action of the balsam. Weickart (1860) first studied the form in which the copaiba enters the urine. He showed that the resinous acid, the copaivic acid, unites in the circulation with the alkalies, and this enters the urine dissolved as sodium copaivate.

In addition the urine contains the ethereal oil, which gives it the peculiar odor of violets. If a mineral acid is added to urine containing sodium copaivate in solution, a whitish flocculent precipitate, very similar to albumin, is obtained. This precipitate induced many observers to really suspect albuminuria and led to the statement that the balsam may give rise to nephritis, an accusation which was repeated in 1872 by Tarnowsky. The precipitate consists of the copaivic acid, which is freed by the mineral acid from its combination with the soda, and is soluble in an excess of the acid. Rocco da Luca and Arnato (1884) have studied the action of copaivic acid and oil of copaiba on blenorrhœa, and have come to the conclusion that neither of these constituents separately has the same effect as their combination in the balsam. Like Quincke (1883) they showed that, on the administration of the pure oil, this passes into the urine as an easily decomposed salt. On the addition of mineral acids to such urine the acid is set free and imparts a purplish-red color, which Quincke calls copaiba red.

Unfortunately copaiba sometimes produces certain incidental effects which interfere with its administration or render this impossible. Thus, it is absorbed with difficulty, produces indigestion after protracted use, and this may increase to severe gastro-intestinal catarrh, unless care is exercised. Less important, but very alarming to the patient, are the phenomena on the integument, which sometimes develop after the first dose. These consist of eruptions, belonging to the class of angioneuroses, such as erythema or roseola, a papular erythema, or, more rarely, urticaria or purpura. The most frequent of these polymorphous eruptions are patches of circumscribed redness, whose color may also vary from dark violet to yellow; they become confluent, their size changes rapidly

and they usually disappear rapidly without subjective symptoms. In many cases the first dose alone is followed by the eruption, which disappears despite the continuance of the medication; in other cases the eruption increases with the further administration. If the eruption is an urticaria, gastric disturbances and pruritus are usually present. The symptoms generally disappear spontaneously as soon as the balsam is discontinued.

Cubebs, the fruit of piper methysticum, like pepper-corns in size and shape, are blackish-green grains with a pedicle. It was recommended freshly powdered as an anti-blenorrhagic after Crawford (1818), an English army surgeon, had learned its use in India, where it is a popular remedy. It is less effective than copaiba, but fell into discredit chiefly because it was given in such enormous doses. Thus Puche ordered, from the beginning of blenorrhœa, ʒ iiss. of the powder on the first day, and then a daily increase of ʒ iiss. until the discharge ceased. Powdered cubebs is given in gr. xv. to xlv. doses two or three times daily in wafers, or the ethereal extract, cubebin, is given in one-tenth this dose. Combinations of cubebs, especially with copabia, are also popular. For example:

℞ Pulv. cubeb., ... ℥ j.
Alumi, ... ʒ ij.
Root sambuci q. s. f. electuarium,
S. 3 to 4 teaspoonfuls daily.

℞ Pulv. cubeb.,
Bals. copaiv., ... āā ℥ ss.
Gummi arab., ... ʒ ij.
Aq. cinnamon., ... ℥ iv.
Syr. cort. aurant., ... ℥ j.
S. 1 teaspoonful t. i. d.

Velpeau (1826), Fenoglio (1846), Caudmont (1861), were special advocates of the combination of copaiba and cubebs, to which they attributed greater efficacy than to each one singly. Sigmund also favored the following prescription:

℞ Pulv. cubeb.,
Bals. copaiv., ... āā gr. xlv.
Extr. gentian q. s. f. pill xxx.
S. 8 to 9 pills daily.

The incidental effects of cubebs are not by far as disagreeable as those of copaiva, although it sometimes produces gastritis or urticaria.

Sandal-wood oil, acquired by distillation from syrium myrtifolium, was recommended by Henderson (1865) and Panas (1865). Although it was repeatedly recommended in France, for example by Nirgon and Pathault, it found favor very late in Germany. It was not until last year, through the recommendations of Posner (1886), Meyer (1886), Letzel (1886), Rosenberg (1887), and Linhardt (1887), that it has secured general recognition. This is so much more deserved because, while equal in efficacy to copaiba, it does not possess the disagreeable incidental effects of the latter. It rarely causes gastritis, but in a few cases it has produced symptoms of renal congestion, which demand a certain degree of caution. It is given in doses of gtt. iij.–x. in gelatine capsules t. i. d., or

℞ Ol. santali, ... ℥ ss.
Ol. menth. pip., ... gtt. iij.
S. 15 to 20 drops 3 or 4 times daily.

Peruvian balsam and balsam of tolu have also been recommended, but only employed for a short time, and are inferior to the others in their effect.

Vidal (1877) recommended gurjun balsam, which had been previously recommended by Henderson (1865) as wood oil. Vidal prescribes:

℞ Balsam. gurjun.,
Pulv. gummi arab., ... āā ʒ j.
Syr. simpl., ... ʒ iij.
Infus. anis. stellat., ... ʒ x.
S. For one day.

Matico, obtained from piper angustifolium, was recommended by Favrat (1861), partly alone, partly in combination with copaiba. Infusions of the leaves were also used for injections. Scarenzio, Sigmund and Jullien deny any curative properties to this drug.

Turpentine, a very effective remedy but difficult of digestion, and which was employed by Swediaur (1798), is usually given in combination with cubebs, rarely alone.

Tar preparations and derivatives have also been used, but only with temporary success. Riemslagh (1862) advised aqua picea internally, Zeissl (1874) inhalations of oleum æthereum pini, Brémond (1874) turpentine vapor baths, Barton (1886) creasote.

Kawa-kawa, the root of piper methysticum, was recommended by Dupouy (1876). He digests gr. lxxv. of the finely cut root in 1 quart of water, filters and administers the gray aromatic fluid. Blackerby (1881) prescribes:

℞	Ext. kawa-kawa fld., ...	℥ iij.
	Spirit æth. nitros., ...	ʒ ix.
	Syr. simpl., ...	ʒ xviij.
	S. 3 tablespoonfuls daily.	

Schutt (1883) prescribes:

℞	Ext. kawa-kawa fld., ...	℥ ss.
	Ext. rhus. aromat., ...	ʒ ij.
	Bals. copaiv., ...	℥ ss.
	Tinct. cubeb., ...	℥ ij.
	S. 4 teaspoonfuls daily.	

Sanné (1886) orders extract of kawa-kawa in pills of gr. iss., 4 to 8 pills daily.

Among other remedies we may mention vinum colchicum opiatum, tinctura colchici, digitalis, hydrastis canadensis, arbutus unedo, gelsemium sempervirens, baccæ myrtillorum, asclepias incarnata, tincture of aloes, hasheesh, amaranthus spinosa, Jamaica dogwood, tinctura sierræ salviæ.

Finally, sal ammoniac has been recommended internally in large doses, potassium bromide in doses of ʒ j.–iss. daily, potassium chlorate gr. xlv. daily, and sodium salicylate ʒ iss. daily.

Local Remedies.

Instrumental.—Local applications or urethral injections have been employed in clap since the earliest times, but they were always used merely as an adjuvant to the internal and general treatment. The syringes used were similar to those now employed. Blegny (1683) portrayed one which cannot be distinguished from one of to-day. Hahnemann used small syphons, Weikard used syringes with a flat end and a small

central opening, which was applied flat against the opening of the urethra. Swediaur (1798) gives directions concerning the construction of a good syringe which differ in no respect from those furnished by Sigmund. Other apparatus was also invented whose object was to render it possible to confine the penetration of fluid to certain parts of the urethra, or to allow it to enter with certainty the deep parts of the canal. To this class belongs Langlebert's syringe, "à jet recurrent" (Fig. 8). To an ordinary syringe is fitted a cannula of platinum or bone, 5 to 6 cm. long, which terminates at the free end in an olive-shaped enlargement. The lumen of the cannula opens immediately behind the olive in four small openings, which run obliquely backwards from within and anteriorly. The fluid always makes its way alongside the cannula to the outside and never penetrates deeper than the olive. Bron's (1858) quite

FIG. 8.

complicated apparatus was devised in order to apply the fluid to a single definite part of the urethra. It consists of a catheter with three openings, situated 2.5 cm. from one another. The first and last openings are concealed by rubber rings, which can be expanded through them. The middle opening is free and serves for the injection, while the rubber rings are distended, and occlude a portion of the urethra anteriorly and posteriorly. Diday (1858) was not the first one who knew that injections with the ordinary syringe did not penetrate farther than the bulb, but his plan was the first which secured irrigation of the entire urethra. While the bladder was moderately full he passed a narrow elastic catheter into the urethra until the urine began to flow and then withdrew it until the flow ceased. The eye of the catheter is then situated in the pars prostatica in front of the ostium vesicæ. A syringe is then fixed to the outer end of the catheter, and the injection made while the latter is slowly withdrawn. So long as the eye of the catheter is situated behind the compressor, the injection fluid passes through the pars posterior into the bladder; when it is situated in front of the compressor, it flows through

the pars anterior to the meatus and comes in contact with the entire urethra. Gurgon's (1867) urethral syringe (Fig. 9) permits applications to definite parts of the urethra. It consists

FIG. 9.

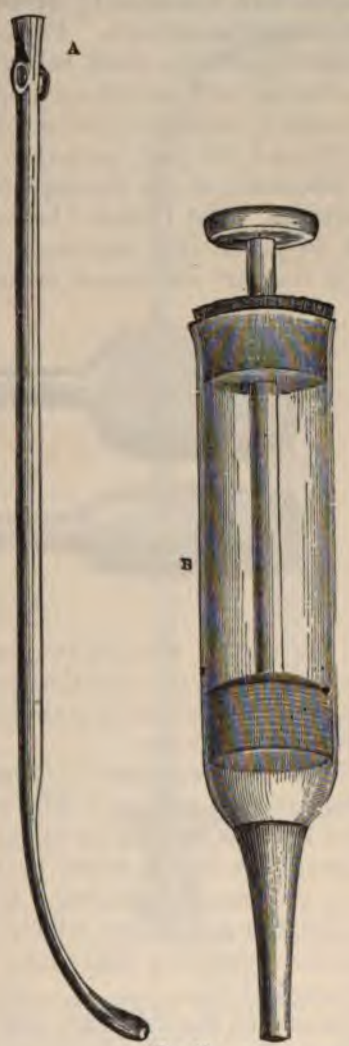

FIG. 10.

of a large Pravaz syringe whose piston is moved by turning a screw. A half turn corresponds to a drop. The anterior, conical, cannula-like end of the syringe fits accurately, by

means of the thread of a screw, into a rubber olive-tipped bougie, which has a fine canal terminating at the tip in a small central opening. The bougie is introduced into the urethra and the fluid deposited by drops in the canal. Durham used a clysopump-like syringe. Prince devised a syringe with catheter-like tips, which could be screwed on, and which possessed an olive tip with lateral openings behind the latter. Milton is thoroughly convinced that injections with the ordinary syringes never reach the pars posterior. Thus we read on page 115 of his discussion on the development of strictures as the result of injections: "But I think I have evidence enough in my possession to prove that injections, as ordinarily employed, never reach the part where most of these strictures begin—that is to

Fig. 11.

say, the bulb of the urethra and its immediate vicinity." He also emphasizes the fact that he has never been able to inject fluid into the bladder by a simple injection in the urethra, even with the aid of force.

With a correct view of these relations Milton devised his "long urethral syringe" (Fig. 10), a catheter, which is introduced into the urethra as far as the bulb, pars membranacea or prostatica, and to whose outer end a syringe, with a capacity of 200 cm., is attached. Burckhardt and Vajda devised complicated apparatus, which are hardly ever used, for the purpose of injecting fluid under high pressure, which could be regulated at will.

Balmanno Squire (1882) describes a simple and convenient syringe (Fig. 11). It consist of a flat, rounded, rubber syringe; two metallic plates, inserted in the two flat sides of the syringe and of the same size, make it possible to empty this handy balloon syringe completely. Ultzmann (1883) describes two in-

struments for irrigation and injection of the posteria urethra. The first, the irrigation catheter (Fig. 12), consists of a silver catheter, 16 cm. long, of medium curve, 14 to 16 Charrière, with the vesical end smooth and rounded. It contains either sieve-

FIG. 12.

FIG. 13.

like openings or four lateral fissures, placed crosswise, 1 cm. long, 2 mm. wide. The extra-vesical part carries a disk of hard rubber, and a mark upon it shows the direction of the tip of the catheter. To the disk is fastened a soft-rubber tube, about 20 cm. long, which connects with an ordinary surgical syringe. The irrigation catheter is introduced into the urethra while

the patient is in the dorsal position, until the penis makes an angle of 120° with the horizontal, the surface of the abdomen. The tip is then in the posterior portion of the pars mem-

FIG. 14.

branacea. The fluid driven by the syringe into the catheter must now pass the pars prostatica and enter the bladder, but cannot regurgitate alongside the catheter. Upon removing the syringe the fluid should not escape from the catheter, as this would show that the tip is situated in the bladder.

The urethral injector (Fig. 13) also consists of a silver catheter of medium curve, 16 cm. long, with a calibre of 14 to 16 Charrière. At the extra-vesical end is an addition of hard rubber into which fits a Pravaz syringe. On introducing the instrument into the urethra the tip of the catheter enters the pars prostatica, when it makes an angle of 135° to the horizontal (Fig. 14). Aubert, Bourgeois, and Erand recommend that injections in the pars anterior should always be made by passing a narrow elastic catheter as far as the bulb and injecting through this. In order to regulate the pressure of the injected fluid, Petersen and I recommended an apparatus coincidently. Instead of a syringe Petersen recommends a rubber tube with an olive tip at one end, a curved glass tube at the other end. This glass tube is dipped into a vessel and the fluid enters the tube by syphon action. The pressure is regulated by raising and lowering the vessel.

My apparatus (Fig. 15) consists of a syringe, with a capacity of 300 to 500 cm., which is hung parallel to the wall and vertical, at about half a man's height. The lower end carries a firm rubber tube about 1 m. long, to which is attached the pear-shaped tip, which can be closed by a stop-cock. The upper end, instead of being fastened by a screw, simply has a cover which is perforated by the piston-rod, and which can be put on like the cover of a box. The piston-rod terminates above in a flat disk, instead of a ring. The syringe is filled in the usual way, by suction through the tube and tip, and the latter must therefore be made of firm material in order to prevent compression by the pressure of the atmosphere. On account of the large dimensions of the syringe one filling suffices for many injections. The apparatus has a double use. It serves as a simple irrigator if the piston and cover are removed after filling. If the pressure is to be increased the piston and cover are allowed to remain and weights are placed upon the disk attached to the piston rod. I begin usually with ½ kilo and increase successively to 3 to 5 kilo. When the piston has a diameter of 4 cm. and the weights amount to 3 to 5 kilo the pressure of the column of fluid on each square centimeter of the urethral mucous membrane is 240 to 400 gm., and always remains the same so long as the simple apparatus works well. Hitches are not apt to occur, except from dryness of the piston, which is soon relieved by oiling.

We need say very little concerning the ordinary clap syringes (Fig. 16). They should have a capacity of at least 6 cm., and at the most of 10 cm. The piston must fit snugly,

FIG. 15.

FIG. 16.

and hence syringes made of hard rubber or tin are preferable to those of glass (in which the lumen is apt to be uneven) with a cork piston. The tip should terminate in a gradually diminishing cone, which will entirely close a large as well as a small meatus, and will only enter a few millimeters. Pear-shaped or duck-bill-shaped tips, which penetrate far into the urethra and close the meatus imperfectly, are to be avoided.

The syringe must also be well oiled so that it works smoothly, and the disadvantages of a jerky, intermittent movement of the piston avoided.

Medicaments.—The number of remedies used for injections is endless.

None has been employed so much, has been extolled and deprecated so much, as nitrate of silver, the most effective of all. Johnston and Barklet recommended it in America, and in Europe it was first introduced by Carmichael (1818) and Serre. It was soon employed not alone for the methodical treatment of clap, but also for the so-called abortive treatment. We will discuss this remedy later and will here simply state that the strength varies between 1.0:30.0 and 0.10 to 250.0 of water, according as it is used in abortive or methodical treatment.

Corrosive sublimate has long been used, and is now recommended anew, on account of its antiparasitic action. Musitanus, Malon, Gardave recommended it, and it was a favorite remedy of Hunter, who prescribed solutions of gr. ij. to ℥ viij. of water. Girtanner and Wallace also used it. It then fell into disuse but was restored to temporary favor by Mueller von Berneck (1846), but it is only since Fantini (1861), Bruck (1876), and particularly since our new parasitological knowledge that it has come into more general favor. When it was known that solutions of 1:3000 to 4000 were sure parasiticides, these were adopted. But Barderzzi (1884), Keyes (1884) and Auspitz (1879) soon were heard in opposition, claiming that such solutions produced violent irritative symptoms. The more recent advocates of corrosive sublimate, such as Chameron (1884) and Vanderpoel (1886) recommend solutions of 1:20000.

Sulphate and acetate of zinc, the former recommended by B. Bell, Lisfranc, Blancard and Large, the latter by Henry, have become lasting additions to our armamentarium, and are successfully used at the present time in solutions of gr. iij.–xv. to ℥ iij.

This is also true of permanganate of potash, which was first used by Rich (1864) in the enormous dose of gr. vj. to ℥ j., and then lapsed into oblivion. It was restored to favor by the recommendation of Bresgen (1867) and is now prescribed in solutions of gr. ⅓–iss. : ℥ iij.

Acetate of lead, recommended by Bertrandi (1790) was favored by Ricord, particularly in combination with sulphate of zinc. This prescription, still known as Ricord's injection, has many advocates. The following is the original prescription:

℞	Zinci sulphat., ...	gr. xv.
	Plumbi acetic, ...	gr. xxx.
	Aq. rosæ, ...	℥ vj.
	Tinct. catechu,	
	Tinct. opii., ...	āā ʒ j.

S. To be well shaken and injected.

Sigmund often prescribed acetate of lead in the proportion of gr. xxx. : ℥ iij. of water.

Chloride of zinc has been recommended by Lloyd (1850), Debeney (1851) and Bumstead (1867). The latter dissolves ʒ iiss. of the chloride in ℥ ss. of water, and injects two to eight drops to a teaspoonful of water three times a day.

Among the alkalies caustic potash 1:200 was recommended by Fordyce (1758) and Warren (1771), and a solution of ammonia by Peyrilhe (1786).

Subnitrate of bismuth, first recommended by Caby (1854), is still often used in the proportion of 2.0:100. Recently there has been much opposition, particularly by Erand (1886), to this remedy, which is insoluble in water, precipitates in the urethra, stops up Morgagni's lacunæ, and leads to the development of urethral calculi.

Chloroform, recommended by Venot (1850) was used for injections, especially by Parona, in the proportion of 1:100 to 200, but produces violent irritative symptoms. This is also true of chloral hydrate, which was used by Lecchini (1874) in a 1 per cent. solution, by Pasque (1880) in a 2 per cent. solution.

Gazeau used sulphate of cadmium in solutions of 1:1000 to 2000.

Chloride of iron in solution of 1:100, bicarbonate of soda, 1 to 100, potassium bromide 5:150, and in 1 to 3 per cent. solutions have also been used.

Tannin alone or as tannin-glycerine was recommended by Lange, Deneffe and Hill, tincture of iodine by Masenel and Paquet. The latter injects tincture of iodine 5.0 in aqua laurocerasi 20.0. Zeller (1875) recommends:

℞	Tinct. catechu, ...	℥ j.–iss.
	Glycerini, ...	℥ j.
	Tinct. iodin., ...	gtt. xv.–xxx.
	Aq. rosarum, ...	℥ vj.

The conviction that copaiba acts locally led Oates, Engelhart and Marchal to inject it in various mixtures. For the same reason Langlebert used eau destillée de copabu.

Among other remedies we may mention oil of eucalyptus, iodoform as injection in a mucilaginous mixture or in bougies. Campana prescribes:

℞	Iodoform.,	ʒ v.
	Acid carbolic,	gr. iss.
	Glycerine,	℥ iiss.
	Aq. destil.,	ʒ v.
	S. For injection.	

Haberkorn and Delorme inject quinine. The latter prescribes:

℞	Quin. sulph.,	gr. xv.
	Acid sulph. q. s. ad solut.,	
	Aq. destil.,	℥ iiss.
	Glycerine,	ʒ vj.

Resorcin is recommended by Muenich and Letzel in a 2 to 4 per cent. solution, Goll recommends thallin sulphate in 1 to 3 per cent. solutions. Blackerby injects fld. extr. yerba reuma 35.0, water 175.0. Schutt prescribes:

℞	Hydrastin muriat.,	gr. ix.
	Iodoform pulv.,	gr. iij.
	Glycerine,	ʒ j.
	Inf. sassafras,	℥ ij.
	S. Four times a day.	

Solid powders, partly inert, partly astringent, such as subnitrate of bismuth, oxide of zinc and iodoform have been recommended by Malles and Cattaneo to be blown into the urethra by means of special apparatus. The disadvantages of the severe irritation and the formation of concretions soon led to the abandonment of such methods.

Finally, we may mention that Ricord, Malgaigne, Desruelles and Tanchon not alone injected astringents into the urethra, but also introduced, by means of sounds, pledgets of lint soaked with the fluids and allowed them to remain several hours.

METHODS.

We will now enter upon the explanation of the various methods which have been used for the cure of urethritis.

Before discussing the application of individual remedies it would be desirable to examine into their mode of action, but unfortunately this can only be done in an imperfect manner. The urethral suppuration, the main symptom of the gonorrhœal process, is merely a phenomenon of resistance on the part of the organism. The gonococci enter the urethra, where they find a suitable soil and proceed to increase. This colonization is not tolerated by the organism, which begins a combat with the virus; the numerous migrating lymph cells become laden with gonococci and endeavor to carry them off. This struggle continues until the last gonococcus has been destroyed or removed. The suppuration and inflammation are therefore necessary to the cure of the affection, so long as they remain within certain bounds. If we do not disturb these processes and no unfavorable external influences intensify the inflammation, it will run its course spontaneously within a certain period. We know that an anterior urethritis, which runs a typical course, lasts five to six weeks. There is one method of treatment, the expectant plan, which is confined to allowing the struggle between the gonococci and the tissues to terminate uninfluenced, and to merely keeping away all noxa which might produce useless or even injurious intensification of the otherwise beneficial inflammation.

A shortening of the course of the disease can only be effected by action upon the gonococci. It is senseless to attempt to shorten the course of the inflammation so long as the inflammation-producers, the gonococci, are still present.

The gonococci can be acted upon in two ways, either directly, by destroying them, or indirectly, by producing a change in their soil, the mucous membrane, which is unfavorable to their proliferation.

We have just mentioned a number of remedies which, when properly used, cause diminution and finally complete disappearance of the gonococci from the secretion, and more rapid recovery of the blenorrhœa, but the manner in which they act is not clear.

I believe that the balsams have a direct parasiticide effect

upon the gonococci rather than an action on the soil, for the reason that urine saturated with the drugs remains acid and sterile for a long time in open vessels, and is therefore a bad soil, at least for those micro-organisms which cause decomposition of the urine.

In the application of astringent injections there is perhaps a double action, *viz.*, destruction of the gonococci and an unfavorable modification of the soil, but only to the extent to which the cocci and soil are exposed to the action of the astringent. This superficial action may explain the fact that the cocci which rapidly penetrate deeply are only destroyed gradually, in the degree to which the suppuration again brings them to the surface, and thus the process lasts a long time.

Treatment of Anterior Urethritis.

We have previously referred to the expectant plan of treatment, which looks only to the most careful acquiescence in hygienic and dietetic measures, but avoids all local therapeutic interference. This method started with the followers of the avirulistic school. It cannot be denied that such measures, which include rest in bed, often suffice for the cure of blenorrhœa, and I have very often observed, in hospital patients, recovery of an acute urethritis in a few weeks as the result of such treatment. But the period in which the blenorrhœa recovers in such cases is usually quite long, dependent upon the soil, the rapid development of the gonococci, and the viability of the pus corpuscles. If the soil is changed as the result of previous blenorrhagic disease, *i.e.*, after repeated infection, spontaneous recovery under expectant treatment is much more difficult of attainment. In the majority of patients, finally, it is impossible to carry out the hygienic-dietetic measures in the strictness necessary to effect a cure.

Next to this is the antiphlogistic method, which, starting from the theory of a simple inflammatory disease, recommended simple antiphlogistic regimen. Diuretics, leeches and venesections are employed, in addition to local applications of cold water. Although we do not favor the first-mentioned remedies, the local application of cold and warm water (the latter warmly extolled by Milton) is a very effective means, not of curing the blenorrhœa, but of keeping the inflammation

within bounds, and preventing exacerbations as much as possible. This is also true of the application of an ice-bag (Shane) or of the cooling apparatus with flowing cold water recommended by Bumstead and Otis.

The topical application of cold water in the form of urethral injections was also recommended by Picard, while O'Reilly, Curtis, Gordon, and Blackwell strongly advised irrigations and injections of water as warm as could be borne.

The medicinal, which is also chiefly a topical method of treatment has for its object to shorten the combat between the gonococci and mucous membrane, by attacking the cocci and also by making the mucous membrane more resisting.

It would be regarded as the ideal of medicinal treatment if we succeeded in preventing at once the further development of a beginning discharge from the urethra (whose blenorrhagic character is shown by the presence of gonococci) by destroying the gonococci, *i.e.*, the virus, and thus removing the cause of the disease. This plan, known as abortive treatment, was formerly practiced a good deal. Musitanus (1701) injected a mixture of calomel, two drachms, and aqua plantaginis, eight ounces; Fordyce and Warren injected strong solutions of caustic potash. Simmons (1786) recommended cauterization with the solid stick of the entire urethra, Ratier of the fossa navicularis. But Debeney (1843) was one of the most active advocates of this method, which was practiced by the French school, particularly by Ricord. Solutions of nitrate of silver of various strengths were always employed in these attempts at abortive treatment (0.7:30.0 by Carmichael, 0.5 to 1.0:30.0 by Ricord, 0.6 to 1.5:30.0 by Debeney). This plan was carried out in the following way. The patient, who was kept in bed, first urinated. The physician then injected a syringeful of the solution into the urethra, at the same time compressing the penis at the root in order to prevent the deeper penetration of the fluid into the canal. After the solution had acted upon the mucous membrane (which is always accompanied by increasing violent pains), it is allowed to escape from the urethra and a syringeful of a one per cent. solution of sodium chloride is injected. The patient, who is placed on somewhat low diet, now applies cold compresses, and takes measures to secure easy evacuations. The first discharges of urine are followed by violent pains. On the next day begins a profuse, bloody, pur-

ulent secretion, which gradually diminishes, and ceases almost entirely on the third day, when a fresh injection is made.

In a certain proportion of cases (Tarnowsky estimates it at about 40 to 50 per cent.), the urethritis is cured in about two weeks under this treatment. In others the inflammatory symptoms become very violent after the injection, pain, chordee and vesical tenesmus set in as distressing symptoms, and the continuance of the abortive plan is made impossible. Berton and Venot often observed other disagreeable complications, such as peri-urethral abscesses, glandular inflammations, epididymitis, as the result of abortive treatment; and Simon, who practiced this method in Germany, observed severe complications, such as prostatitis and cystitis, in four per cent. of the cases. Langlebert used his syringe "à jet recurrent," in order to confine the injection to any part of the canal desired. Chloride of zinc gr. ¾ : ℥ j., chloroform 1:30, aqua calcis 1:4, and alum 6 to 10:150 have also been recommended for abortive treatment. This was also attempted by the administration of large doses of copaiba and cubebs, but without striking benefit. The recent investigations on the rapid penetration of the gonococci into the deepest layers of the epithelium, and into the upper layers of the papillary body, offer no inducement for a return to the abortive plan of treatment. We could expect success from those remedies alone which would destroy the entire epithelial layer and would penetrate to the papillary bodies. Hence the damage would be much greater than the good to be derived from certain destruction of the gonococci.

The only method of treatment that we practice at the present time is the methodical, local, symptomatic and curative plan. This plan, which is most generally adopted to-day, is unfortunately founded to too great an extent on an empirical basis, but we should combat the thoughtless and routine manner in which the method is carried out. The consideration of the individual symptoms and the adaptation of the treatment to the requirements of the individual case alone can be followed by success.

Symptomatic treatment, directed against individual symptoms, is always indicated when the symptom in question requires repression. But is causal treatment always indicated, so long as the process is present? We must answer this in the

negative, and will mention a number of indications under which alone topical treatment is indicated.

1. Causal topical treatment with balsams and astringents is only indicated in uncomplicated blenorrhœa. A series of extensions of the blenorrhagic process, such as cavernitis, cowperitis, prostatitis, epididymitis, cystitis, are produced by the spread of the inflammation from the diseased mucous membrane to adjacent organs. As soon as one of these complications develops, the topical treatment of the urethritis must be discontinued at once. In the first place a remission of the urethritis generally occurs on the development of the complication and makes its treatment temporarily superfluous. In the second place—and this is the most important reason and also holds good if the expected remission does not appear—every interference on our part during the existence of a complication usually aggravates the latter.

2. Early topical treatment, at a time when the disease is still increasing in intensity or is at the acme, is not indicated, and it should not be begun until the inflammation has passed the acme.

We have previously discussed the action of balsams and astringents on the urethral mucous membrane and have said that, under their influence, the number of gonococci and the amount of the secretion diminish. It might therefore be supposed that they should be given at the very onset of the disease, since it might be expected that the course of the disease would be made milder, that the inflammation would not rise so high. Whether this is so if injections are begun in the initial mucous stage, I do not know. Cases of this kind very rarely come under our observation, because the initial stage is so brief that it is generally overlooked by the patient. But if the purulent stage has set in, internal treatment should be employed with caution. If the inflammation is very acute, injections should not be ordered until the process has passed its acme. I know that I am at variance, in this matter, with some of my most prominent colleagues, who inject from the very beginning. But my conviction is founded not alone on an empirical but also on a scientific basis. My reasons for this view are the following: It is a well-known fact in the study of all catarrhal diseases that astringents, which diminish an inflammation so long as it is moderate, when applied to an

intensely inflamed mucous membrane, often aggravate the severity of the inflammation. From Bumm's investigations on the development and spread of gonococci in blenorrhœa conjunctivæ we know further that the cocci penetrate rapidly to the papillary body and spread there, whence they are gradually carried to the surface, and that it is only during the later period of the purulent and the entire muco-purulent stage that they proliferate upon the epithelial surface. Hence it follows that the gonococci are protected from astringents by their deep situation, until the acme is passed.

Injections made before this time will, at the most, exercise an astringent effect on the mucous membrane, but will not destroy the virus. This action on the mucous membrane I regard as directly injurious. It is a matter of frequent observation that early injections in the acute stage repress the discharge, but that it returns as soon as the injections are discontinued, and then resumes its progressive course. Moreover, every recrudescence of the discharge after a certain period of such injections is more acute, and the process is intensified with every relapse. I have had several opportunities of examining these relapsing discharges in patients who, when suffering from a fresh urethritis, began to inject as soon as the first symptoms were noticed, whereupon the symptoms subsided. But when these patients, thinking that they had recovered, ceased to inject, the discharge reappeared with increased violence, with an acuteness which exceeded that of the first attack. I was always astonished in such cases by the enormous number of gonococci in the secretion, a number which was never approached when the acute stage ran its typical course without interference. Not alone were large numbers of pus and epithelial cells filled with gonococci, but there were also a large number of cocci heaps, which often aggregated many hundred individuals, free in the secretion—an appearance never seen in the normal course of the disease. There seems to me to be only one explanation of this striking fact, *viz.*, that the astringent action of the injection has inhibited the development of the inflammatory reaction of the mucous membrane, while the gonococci, protected from this action by the epithelial layer, proliferated undisturbed. But when, with the cessation of the astringent action, the inflammation again started up, the intensity of the latter must become greater in corre-

spondence with the larger number of gonococci, and will be still more intensified if the inflammation is again inhibited by renewed injections.

I therefore repeat that I do not consider topical interference, especially injections, indicated until the blenorrhagic inflammation has passed its acme, and the cocci, which are then proliferating on the surface of the epithelium, are open to direct attack.

3. The intensity of the topical interference must be inversely proportionate to the acuteness of the inflammation. The more severe the inflammation the milder the local measures, and *vice versâ.* We therefore use the mild treatment with balsams before the injections, then inject weak solutions of the milder astringents, and finally stronger solutions in increasing concentration and frequency. It should not be forgotten that suitable astringent action diminishes the intensity of the inflammation, a too strong action increases the intensity of the process, and thus gives rise to renewed invasion of the gonococci into the epithelium which has been fissured by the increased irritation.

The method of administration of the balsams will be considered in the discussion of the systematic treatment, but we will here make a few general remarks on injections. In acute anterior urethritis the injections are made by the patient with the clap syringe or my apparatus.

The utmost cleanliness should be observed. The apparatus used for injections should be carefully cleaned in order that no germs which have developed in it can enter the urethra with the fluid. The solutions employed should also be aseptic, and vegetable injections must therefore be eschewed. Palliard reports a case in which a young man, æt. nineteen years, injected an infusion of various herbs in recent urethritis. Three days after the first injection he was attacked by epididymitis and cystitis. The urine was cloudy and contained numerous bacteria, which the writer justly assumes to have been imported into the urethra with the injection.

The mode of injection must be carefully described and shown to the patient. The solution must come in contact with the entire diseased mucous membrane, and must therefore penetrate to the bulb. This is only possible if the patient places the tip of the instrument in the meatus in such way that no fluid can

escape. The fluid should be injected gently and uniformly. Violent, forced, rapid injection is apt to produce reflex contraction of the ischio-cavernosi and bulbo-cavernosi muscles, which often eject the fluid from the urethra in the form of an ejaculation.

The amount of fluid should always be so large that it will render possible a slight distention of the mucous membrane, an effacing of the folds, and entrance of the fluid into the openings of the follicles. The amount varies according to the inflammation, but we may say that it should always be so large that the distention of the mucous membrane caused thereby begins to grow annoying or painful. In the beginning, so long as the membrane is very much swollen on account of the acute inflammation and its elasticity is slight, a small amount of fluid will produce painful distention. When the process becomes older, the amount of fluid must be increased. These demands can be fulfilled very well with my apparatus. In the acute stage the patient uses it as an irrigator (without the piston) and allows the fluid to enter under slight pressure until the distention begins to grow painful, when he closes the stop-cock. When the process is older he allows larger amounts of fluid to enter under the gradually increasing pressure of weights placed on the disk of the piston, until the same effect is felt.

The injected fluid must remain for some time in the urethra in order to act sufficiently upon it.

It should always come in contact with the cleaned mucous membrane. The bladder should be evacuated and one or more injections of lukewarm water made before the fluid is introduced.

At first the injections should be made only once a day, viz., at night, then the number may be increased to two, three, finally four. Too many injections irritate excessively.

Having mentioned the general indications and recommendations we will now proceed to the consideration of the treatment of a typical case of acute anterior urethritis.

If a patient with recent acute urethritis—say about the second week after coitus (more recent ones, as we have said, are rare)—comes under treatment, our first care should be to recommend strict hygienic-dietetic rules. One question, which we must often answer at once, concerns the amount of fluids

to be drunk. Some recommend very little fluid, in order that the urethra may be irritated as little as possible by urination, others recommend copious drinks, in order that the diluted urine should irritate the urethra only slightly. Both forget that a single discharge of concentrated urine may irritate as much as the frequent passage of diluted urine, and that both extremes should be avoided. In other respects we proceed symptomatically, combat sexual excitability with the well-known remedies, acute inflammatory phenomena with the application of cold compresses, which are employed for one or two hours morning and evening. If the acute symptoms are very violent, local treatment is contra-indicated. There are a few remedies which seem to alleviate the pain in micturition, for example:

℞ Decoct. semin lini., ... ℥ xvj.
Syr. diacorii, ... ʒ iiss.
S. One tablespoonful every two hours.

℞ Herb. herniar.
Fol. uvæ ursi, ... āā ℥ j.
S. To be used as a tea.

Two or three cupfuls of the latter mixture may be taken warm daily. Fournier recommends:

℞ Sodii bicarb., ... ʒ j. gr xv.
Sacch. alb., ... ℥ j.
Succi citri, ... gtt. ij.
S. To be taken in one day.

This is dissolved in about 1 litre of water and taken cold.

If the inflammatory symptoms are slight, we may give local remedies even in this stage, prescribe a few capsules daily of oil of sandal wood or copaiba. These must be discontinued at once, however, if the irritative symptoms increase.

Towards the end of the second week or beginning of the third week the acute symptoms increase. The same regimen as before is continued, but more strictly. Rest, hygiene and diet must be very carefully watched. Antiphlogosis is useful only when carried out persistently. Employed for a time only, especially in the form of cold baths, it is injurious, inasmuch as the temporary relief is followed by a so much more violent

reaction. The sexual irritability, the erections and insomnia, demand decided interference. We must not be afraid to secure the greatest possible amount of rest by suitable doses of the previously mentioned antaphrodisiacs, potassium bromide, camphor, lupulin, chloral hydrate, morphine injections, and at the same time order mild vegetable diet, and secure regular evacuations from the bowels. If the inflammatory symptoms are violent, as happens not infrequently at this time, we must enter the field with our entire antiphlogistic armament. Thus, œdema, lymphangioitis, chordee, require rest in bed, low diet, persistent application of cold compresses or ice bags, inunctions of gray ointment, and narcotics. In addition to morphine injections suppositories are especially suitable:

℞ Ext. belladonnæ, ... gr. ij.
or morphin. muriat., ... gr. ij.
Butyr. cacao,
Ungent. cinerit., ... āā ʒ ij.
F. supposit. No. x.
S. Two to three suppos..ories daily.

Next to chordee dysuria is particularly to be treated with narcotics. The catheter should never be used unless the indication is absolutely imperative.

Protracted warm baths, if preceded by narcotics, often secure easy and relatively painless micturition in dysuria. In other cases dipping the penis in cold water is attended with good results.

If the urethritis is not attended, even in this stage, with very severe inflammatory symptoms, and the administration of sandal-wood oil, etc., has been well tolerated, these drugs are to be continued.

But injections should never be made until the inflammation has passed its acme. In some cases the transition is slow, in others rapid. The remission of the symptoms is the sign for administration of the balsams in those acute cases in which no local treatment has been hitherto adopted.

We proceed to injections when the decreasing stage is well established. The pus, still abundant, loses its greenish tinge, becomes thin and milky. The pains on urination and erection are slight and rapidly diminish, the sexual irritability subsides. But it must not be forgotten that it is at this very time that

posterior urethritis may develop. Before ordering injections the physician must, therefore, satisfy himself concerning the condition of the pars posterior, and repeat this examination frequently during the further course of treatment. Not all injection fluids have the same value. We have already stated that the remedies and their strength must be increased. I can recommend the following practicable gradation: potass. hypermang. (gr. $\frac{1}{3}$–$\frac{3}{8}$: ℥ iij.), zinc. acetic. (gr. iij.–ix. : ℥ iij.), zinc. sulph. carbolic. (gr. vj.–xij. : ℥ iij.), argenti nitras, (gr. $\frac{3}{4}$–iss : ℥ iij.). The latter, one of the most effective remedies, is usually injected once, at the most twice a day. It is generally accompanied by somewhat increased burning and, especially in the beginning, by greater purulent reaction, for which it is advisable to prepare the patient.

The injection should never cause more than a slight burning in the urethra. The urethra generally accommodates itself very rapidly to the remedy. An injection which burns to-day will be felt very little or not at all in a few days. In the latter event its action may also be regarded as illusory. Hence it is advisable to increase the strength of the fluid every few days within the limits mentioned, and also to change the injection fluid.

A very important question is, when is an acute urethritis to be regarded as cured,—when may the treatment be discontinued and the patient return to his ordinary habits of life?

Unfortunately mistakes are often made in practice by physicians and patients, both in the direction of too brief and insufficient treatment, and also of excessively protracted treatment.

Many patients are satisfied when the visible discharge of pus ceases. Unfortunately many physicians also discontinue the treatment when the patients inform them that the discharge has ceased.

It is clear *à priori* that considerable amounts of pus still flow from the pars anterior. But if the amount of pus is small, it remains upon the mucous membrane of the urethra, spread out in a thin layer, and is only washed away by the urine during micturition. This occurs so much more readily because the small amount of pus of the terminal stage is mixed with considerable viscid, tough mucus, which favors its adhesion to the mucous membrane. This muco-pus is produced mainly in

the bulb, inasmuch as the process, in typical acute anterior urethritis, passes from before backwards and halts in the third week at the bulb. Recovery also occurs in the same direction, so that in the fifth week the pendulous portion is healthy and the process is situated exclusively in the bulb. This is the time when no more secretion appears and many patients and physicians regard the process as cured. Thus urethritis of the bulb, while recovering, is most frequently disturbed in its normal course, and hence the most frequent localization of chronic urethritis in the pars anterior is found in the bulb.

The premature cessation of treatment can only be avoided by examination of the urine. Inasmuch as the acid urine coagulates the alkaline mucus, the small amount of pus will appear in the urine in the form of compact threads and flakes, the so-called clap threads; the urine is otherwise clear. So long as clap threads are found in the urine the process cannot be unreservedly regarded as cured.

Not infrequently, on the other hand, the disease is treated for too long a period. After every urethritis a certain irritative condition of the urethra remains, and is shown by increased secretion of clear, gelatinous mucus, as in urorrhœa. It is especially in the morning, when the patient has been troubled by erections during the morning sleep, that the mucus appears in increased quantity, glues together the lips of the meatus, or appears as a clear drop on pressure. Many patients regard this condition as blenorrhœa.

If this mucous secretion is left to itself, and care paid merely to the keeping away of external irritants, it will disappear spontaneously. But in the belief that it is a part of the urethritis the injections are continued. These constitute an irritant, however, and increase the secretion and irritative condition of the mucous membrane which gives rise to it. It often happens that physician and patient become impatient, and resort to a more vigorous injection. This stimulates the desquamation and proliferation of the epithelium, which, mixed with the mucus, gives the latter a gray or whitish color, which in turn seems to demand further injections. The patient thus enters a circulus vitiosus, the secretion becomes permanent, and if irritant bacterial immigration occurs as the result of uncleanliness, the beginning is made of one of those forms which have hitherto been called chronic urethritis.

The question of the duration of treatment can therefore not be answered by the secretion but only by examination of the clap shreds. There are two factors, in the main, which will prove decisive, *viz.*, the pus corpuscles and the gonococci. So long as the clap shreds contain gonococci, even if they are single, the treatment is to be continued. But even if the gonococci are missed in one or the other examination, the treatment is to be continued if the shreds are rich in pus cells. It happens not infrequently that pus cells but no gonococci are found in the shreds for two or three days. On the fifth or sixth day a few cocci again appear. And so the presence of large numbers of pus corpuscles is evidence of the existence of an inflammatory focus, whose cause may be attributed with great probability to the gonococci. But if the gonococci and pus corpuscles are both absent in the shreds, or the pus cells are present in very small numbers, while the majority of cellular elements are epithelial, the time for discontinuing treatment has arrived. The inflammation has then run its course and we have to deal merely with abundant desquamation of the young epithelium, which will only be increased by injections.

It is well to discontinue the injections gradually, not suddenly, one injection being made at first every second day, then every third day, etc.

After the injection cure is ended, the patient, adhering to the usual regimen, should be kept under observation for ten to fourteen days, and not until this period is past and the urine has remained clear, may we permit a gradual return to the ordinary mode of life. We must emphasize the advice that the return should be gradual, the patient indulging at first in the less dangerous privileges, and reserving coitus for the last.

This is the symptomatic treatment of an acute, typical anterior urethritis. In the most favorable event it requires a period of six weeks, a fact which it is well that the patient should be advised of beforehand.

Not infrequently, however, subacute urethritides, which have lasted several months, come under our treatment. The delay is due to improper management, lack of treatment, premature, improper, or interrupted treatment. In these cases we must inform ourselves concerning the presence of gonococci in the secretion and also concerning the cause of the delayed recovery. When it is the result of insufficient care and im-

proper regimen, these must be regulated; when treatment has been lacking, rapid cure is usually effected. The most unfavorable cases are those which have been protracted by untimely and unsuitable treatment. In such cases I have made it a rule, and always with good results, to treat expectantly at first, merely regulating the regimen. If all local treatment is abandoned the blenorrhœa at first usually increases in severity, and usually passes a certain acme. This generally takes place within ten to fourteen days, during which period the patient is only treated symptomatically; if the intensity of the process is not considerable, balsams may also be used but injections may not be employed. It is not until the process has passed its acme that I begin with systematic injections, which secure rapid recovery, provided that no injurious influences are at work.

Blenorrhœas of cachectic, poorly nourished individuals, who are sick from other causes, deserve special attention. If they run a very acute course, they are treated in the ordinary way, except that tonic treatment is added, nourishing diet, iron, but particularly iron and arsenic in the shape of Roncegno water and Levico water.

In these cases, however, the blenorrhœa often runs a torpid, mild course from the start, the inflammatory reaction is slight, the secretion thin and milky. Such a course indicates, from the beginning, tonic regimen, the well-known hygienic-dietetic measures, and cautiously conducted systematic injections. The patient should always be prepared for a protracted illness and careful attention must be paid to posterior urethritis, which is apt to develop in a latent manner in these cases and to give rise to complications. In the event of such a complication the injections must be discontinued at once.

Treatment of Acute Posterior Urethritis.

Acute posterior urethritis is a complication of anterior urethritis which develops either at the acme of the inflammatory process (in the third week), or subsequently from an exacerbation of the acute urethritis.

On the development of and during the acute stage of this, as of all other complications, the main rule is the cessation of all treatment, particularly local, of the anterior urethritis.

If the posterior urethritis has developed at the acme of the inflammation, no local treatment would have been adopted in any event. But if it develops later, from an exacerbation of the process, injections have already been ordered, perhaps, for the anterior urethritis. The local treatment must then be abandoned at once upon the development of the posterior urethritis.

It is then our first task to treat the posterior urethritis, and to treat the anterior urethritis only after the former is cured.

The posterior urethritis, on the other hand, may again give rise to a spread of the process, to the development of complications. In this event the complication, for example, cystitis or prostatitis, must first be treated, then the posterior urethritis and finally the anterior urethritis.

The hygienic-dietetic measures are the same as in anterior urethritis.

The general indications are also the same in both. The most acute stage is treated symptomatically, the diminishing but still acute inflammation is first treated with mild then with more vigorous local remedies, at first with balsams, then with injections.

The symptomatic treatment of the acute stage is like that of anterior urethritis. Two factors demand special attention, *viz.*, the hæmaturia and the disturbances of micturition.

Hæmaturia is always an evidence of intense inflammation, and is associated with violent tenesmus; indeed it is usually caused by the latter. In some cases treatment of the tenesmus suffices to relieve the hæmaturia. The former demands our entire antiphlogistic armamentarium. In addition to rest, low diet and free evacuations, protracted lukewarm baths often render good service. But the greatest benefits are obtained from narcotics. Injections of morphine and suppositories of belladonna always relieve the tenesmus, and also the inflammation, inasmuch as the latter is intensified by the former. The previously mentioned decoctions, either with or without narcotics, such as infus. semin. lini, herniaria, folia uvæ ursi, also cause some amelioration and are indicated in the acute stage.

If the hemorrhage in the last drops of urine does not cease with the tenesmus, the former must be treated alone with hæmostatics, especially iron and ergotin. We prescribe:

℞ Ferri sesquichlor. sol., ... ʒ ss.
Aq. destil., ... ℥ vj.
Syr. cinnamon, ... ʒ v.
S. One tablespoonful every two hours.

℞ Ext. secal. cornut., ... gr. xv.
Sacch. alb., ... gr. xxx.
Mf. pulv. div. in dos. v.
S. One powder every three hours.

℞ Ergotini, ... gr. xv.
Opii, ... gr. iss.
Sacch. alb., ... gr. xxx.
Mf. pulv. div. in dos. v.
S. One powder every three hours.

Granules of Bonjean's ergotin or subcutaneous injections of ergotin are also given with advantage.

Dysuria, which is not infrequent in acute posterior urethritis, is also a spasmodic symptom, and therefore to be treated, in the main, by morphine and belladonna. The introduction of the catheter is to be avoided or reserved for the most urgent cases. A narrow elastic catheter may then be used during chloroform narcosis or after the administration of morphine (subcutaneously or in suppositories).

When the irritative symptoms have disappeared, in the main, and albuminuria is not present, we may proceed (in addition to the continuance of mild narcotic treatment by administration of two belladonna suppositories or infus. semin. lini with syrup. diacodii) to cautious local treatment. We may give a few (4 to 6) capsules of sandal-wood oil or copaiba, but these must be discontinued at once if more marked irritative symptoms, particularly increased tenesmus, become noticeable.

If the patient does not tolerate the balsams, we may give, instead of or in addition to them, salicylate of soda in doses of gr. xxx. three times a day.

When all irritative symptoms have disappeared for several days, especially if there is no severe tenesmus or albuminuria, and if the cloudiness of both portions of urine is decidedly lessened, we may proceed to local treatment with astringents.

We have previously stated that astringents, injected with the ordinary clap syringe, do not enter the pars posterior, and

hence this method of injecting is to be avoided in the treatment of posterior urethritis.

The French recommend, in order to carry the fluid by means of the clap syringe into the pars posterior, to close the meatus and to push backwards the fluid in the urethra by means of pressure. This manipulation succeeds in some cases. The patient then finds that the pendulous portion, which was at first tense, becomes more flabby, and when the meatus is released, very little fluid escapes from it. In other cases, however, the fluid is ejaculated from the urethra by reflex, jerky contractions of the bulbo-cavernosi and ischio-cavernosi muscles as it reaches the compressor.

This method is uncertain, and is always irritating even in the event of success. We deprecate it accordingly, and with Ultzmann, Aubert, Erand, maintain that posterior urethritis should always be treated by the physician by direct local application of the remedy to the pars posterior.

It must not be forgotten that when the acute posterior urethritis is at a period suitable for injections, an anterior urethritis is also present, older and less severe than the former, and also suited to treatment with injections.

It will be our object, in all these cases, to secure contact of the astringent solution with the entire urethra, from the external to the vesical orifice.

The patient should never make the injections in posterior urethritis with the clap syringe. The anterior urethritis may be healed in this way, but the posterior urethritis, if not aggravated, is at least left to run its spontaneous course, which usually terminates in chronicity of the process. The best method of injection is that of Diday, or the use of Ultzmann's irrigation catheter, with distribution of the fluid over the entire urethra. In order to make the entrance of the solution into the bladder entirely innocuous it is advisable to make the injections when the bladder is moderately full. The removal of the fluid from the bladder is unnecessary, the solutions are to be lukewarm, and ʒ vij.–x. in amount, of which somewhat less than half is intended for the pars posterior, the remainder for the pars anterior. The urethra must be clean before introduction of the instrument, and the patient should therefore evacuate some, but not all, the urine in the bladder immediately before injection. In sensitive individuals a mor-

phine suppository may be introduced before the first injections in order to avoid disturbing reflex contractions of the compressor. The injections should be made, at first every third, later every second day.

The following fluids may be prescribed:

℞	Acid carbolic., ...	gr. xv.
	Aq. destil., ...	℥ xv.
℞	Potass. hypermang., ...	gr. iij.–viiss.
	Aq. destil., ...	℥ xv.
℞	Argent. nitrat., ...	gr. iij.–xv.
	Aq. destil., ...	℥ xv.

If the subjective symptoms have disappeared and the objective signs consist merely of slight mucous cloudiness of both portions of urine, we may advantageously employ the solutions recommended for acute anterior urethritis, particularly argenti nitrat. 0.1 to 0.2:100.0.

Acute posterior urethritis usually heals more rapidly than the anterior, so that we generally find, after the treatment has been continued for some time, that the second morning urine is entirely clear while the first is still slightly cloudy, *i.e.*, the posterior urethritis is cured, the anterior urethritis still present. Irrigations are then unnecessary; the anterior urethritis is to be treated with the clap syringe, and the treatment then discontinued in the manner described above.

CHAPTER III.

CHRONIC URETHRITIS.

ETIOLOGY.

CHRONIC clap was recognized at a later period than the acute form, and although urethral stricture and its treatment by dilatation were known since the middle of the sixteenth century, the course and characteristics of the preceding chronic urethritis were not closely studied until the beginning of the present century. Girtanner (1788) characterizes chronic clap as: stillicidium muci puriformis vel limpidi ex urethra vix inflammata, sine stranguria, erectiones non dolorificæ, ab ulcere urethræ, aut a coarctatione præternaturali urethræ. Kucher (1785) defines chronic clap as a discharge of moisture which is left over after a clap, and results from the weakness of the parts which have been affected. Eisemann (1830) applies the term chronic to every case which lasts more than twenty-one days.

We have said that acute urethritis passes through a mucopurulent and mucous terminal stage before recovery ensues. This stage may become permanent, and it is to this protracted symptom-complex of the terminal stage of acute blenorrhœa that we apply the term chronic blenorrhœa.

This determines the etiology of chronic blenorrhœa in the widest sense. Every chronic urethritis develops as the sequel of an acute or subacute urethritis, whether anterior or posterior.

Anterior urethritis no longer extends, in its terminal stage, over the entire mucous membrane of the pars anterior. In the terminal stage of the acute process the blenorrhagia is usually healed in the pendulous portion and is localized in the bulb. If it becomes permanent it remains localized, and the bulb is therefore the favorite site of chronic anterior urethritis.

Acute posterior urethritis extends rapidly over the short pars posterior, and the entire mucous membrane is always found in the same stage of the disease. Hence it will pass as a whole into the chronic stage. Isolated chronic disease of the membranous or prostatic portions, while the blenorrhœa is healed in other portions of the pars posterior, is rare, although sometimes observed.

We will therefore define chronic blenorrhœa as the permanency of the mucous terminal stage of acute urethritis in a circumscribed portion of the urethra, with recovery in other parts. Its favorite sites are the bulbous, membranous and prostatic portions.

Its causes are in part neglect of the acute blenorrhœa in the sense of insufficient treatment, in part and more frequently, recurring relapses as the result of external injurious influences, and finally, rapidly recurring fresh infections.

We have already discussed the drawbacks of insufficient treatment. The diagnosis of recovery is often made prematurely because suppuration has ceased, while complete recovery has not occurred; but the process, which is confined to the bulb, produces too little pus to appear in the form of a discharge. And so the disease in the bulb remains untreated and becomes chronic.

In the same way the localization of acute urethritis is usually made very loosely or not at all, and the treatment only carried on with the syringe.

Now, if a mild posterior urethritis was present in addition to the anterior urethritis, the former is apt to be overlooked and alone remains chronic. To the insufficient or improperly localized treatment, are usually added other active injurious factors. The patient, either on his own responsibility or that of his physician, regards himself as cured and lives accordingly. This is usually attended with so much more serious results to the not entirely healed process, because the patient believes that he should make up for the hardships of the period of treatment. Then comes a relapse, which is treated and disappears. Then follows another relapse on account of premature return to the usual mode of life. Thus relapse follows relapse, each succeeding one less pronounced and shorter, but with each one the process becomes more and more firmly seated, the local changes deeper and more serious.

The same condition is observed in recent infections if these follow one another rapidly. Their acuteness successively diminishes, they grow more torpid and subacute, but each becomes more obstinate. The long duration alone predestines the transition to chronic blenorrhœa, because its mild course does not convince the patient of the necessity of thorough treatment, proper hygiene and diet.

There are also certain factors within the organism which favor the development of chronic blenorrhœa.

We have already said that torpid subacute blenorrhœas have a special tendency to pass into the chronic stage. On the other hand we know, from the symptomatology of acute urethritis, that this is more apt to run a torpid subacute course in cachectic, scrofulous and phthisical individuals.

Finally, the transition of many blenorrhœas into a chronic stage is attributed to a narrow meatus, to the stasis and regurgitation of the stream of urine which passes through the entire urethra in a broader column.

Nevertheless the real etiological factor of chronic, as of acute urethritis, is the gonococcus, which has a fixed settlement on circumscribed portions of the urethra. This will be considered more fully in the sections on symptomatology and anatomy. To one fact I wish to call attention here, *viz.*, that the gonococci usually suffer enfeeblement during their long protracted stay on the mucous membrane. It has, at least, been claimed by several writers (Noeggerath, Milton, Schwartz) that women are infected by their husbands, who suffer from chronic gonorrhœa, with urethritis which runs a chronic course, and very rarely with acute blenorrhœa.

Symptomatology.

The symptomatology of chronic urethritis is usually described as the escape of a yellowish or whitish drop from the urethra, and gluing together of the meatus, without subjective phenomena; these symptoms may be aggravated by external injurious influences.

This clinical history is inaccurate and corresponds to only a single form of chronic urethritis. All the different varieties cannot be brought under one head, and require special consideration.

The symptoms and course vary not alone according to the localization, but also according to the depth to which the circumscribed inflammatory process has extended. In some cases it affects only the mucous membrane, in others also the submucous cellular tissue and other subjacent tissues.

From this stand-point we may distinguish several forms, which can all be arranged in two groups.

We have said that one of the characteristics of chronic blenorrhœa is its circumscribed localization. But if we include in the category of chronic blenorrhœa only those cases in which the process is really confined to a quite sharply defined spot, we would have to exclude a series of cases, because, although they present a torpid course and absence of acute inflammatory symptoms, congestive phenomena are also observed on larger or smaller portions of the mucous membrane. These are the transitional forms between acute and really circumscribed chronic urethritis.

The differentiation between these two forms, which I will call recent and inveterate chronic blenorrhœa, depends on the character and quantity of the secretion. If the urine, especially the morning urine, is examined in a large series of cases of chronic urethritis, the characteristic clap threads will usually be found. These shreds are the product of the circumscribed process which constitutes the chronic urethritis. In the one series of cases the shreds are found floating in cloudy urine, in the other in clear urine.

The cloudiness in the more recent cases of chronic urethritis is caused by mucus, and is owing to the fact that, in addition to the circumscribed patches which produce the shreds, there are more or less extensive parts of the mucous membrane in a condition of catarrhal hypersecretion, while the clear urine in the second series of inveterate chronic urethritis indicates that the remaining mucous membrane is normal. If an inveterate chronic urethritis is irritated by external influences, the symptomatology of the more recent form is not infrequently produced, but disappears after a longer or shorter interval. In like manner, the clinical history of the more recent form passes, in time, into that of the inveterate form.

Several forms of chronic urethritis may be differentiated according to the localization.

Chronic Urethritis of the Pars Pendula.

This furnishes the picture of the usually described typical goutte militaire. When the patient examines the penis in the morning, he finds a drop emerging from the meatus, yellowish or milky in the more recent cases, grayish white in older ones; in the latter event it not infrequently contains whitish little clumps. The morning urine, which is passed without pain, or, at the most, with slight burning and tickling at the orifice, is clear or cloudy and contains shreds. If the patient urinates in two vessels, that passed first alone is flocculent, and clear or cloudy, the second is always entirely clear. During the day the meatus is usually glued together by a small amount of mucus; the first usually clear urine contains flakes, but in smaller amount than in the morning. If the process is more recent and the mucous membrane hyperæmic, the mucus is stained more or less yellow by the larger or smaller amount of pus produced by the mucous membrane which is in a condition of chronic infiltration. This mucus escapes in the morning as a drop at the meatus, while that produced during the day, being smaller in quantity because washed away at shorter intervals by the urine, merely agglutinates the meatus. In the older cases the pus from the diseased portions of the mucous membrane is washed away by the first urine, and hence cloudiness of the second urine is impossible in both cases. Exacerbations of this chronic condition as the result of external irritants are so much more easily recognized.

Chronic Urethritis of the Pars Bulbo-Membranacea.

This presents a much more obscure history. If the pus is formed in the bulb or pars membranacea in small quantities, it will remain in these parts, especially in the sac of the bulb, and only appears in the first urine as clap threads, but does not flow out of the meatus nor is it visible as a drop. If the chronic urethritis is more recent, and the congestion and production of mucus upon large portions of the mucous membrane of the pars pendula are more extensive, the mucus may reach the meatus and agglutinate it. But if the urethritis is old, this mucus at the orifice is absent, the process is only noticeable by the clap shreds. The patient, in the absence of all symptoms, naturally regards himself as well. Slight ex-

acerbations, such as burning during micturition, are explained by the new beer which the patient drank on the previous evening, and more severe relapses are regarded and treated as mild, new infections.

So long as the process remains localized in the mucous membrane, these are the symptoms which may persist for years. Whether such a chronic urethritis, situated solely in the mucous membrane, may heal as the result of recovery of the spot of infiltration by the formation of connective tissue and superficial cicatrices, we do not know. When the process extends to the submucous tissue, to the corpus cavernosum, and the chronic infiltration heals by the formation of retracting connective tissue, a new and gradually developing symptom of more serious significance is added to the clinical history, *viz.*, narrowing or stricture. Apart from spasm urethral strictures also arise from organic causes, from swelling or infiltration of the mucous membrane, or the formation of cicatrices. The former, known as soft strictures, are succulent, yielding, rarely attain a notable degree, indeed the stenosis is usually insufficient to narrow the pars pendula and bulbosa to the dimensions of the orifice. They cannot be detected, as a general thing, with the ordinary sound, but only with sounds of large calibre or urethrometers. Otis calls them "wide strictures." On the other hand, the strictures formed by retracting tissue have a tendency to constantly increasing narrowing. They are situated mainly in the bulb and its vicinity. Of 320 strictures, whose locality was examined by Thompson, there were situated:

1. At the orifice of the urethra and within two and a half inches of the pars pendula, 54=17 per cent.

2. At the middle of the pars spongiosa, two and a half to five and a half inches from the orifice, 51=16 per cent.

3. In the subpubic curvature, *i.e.*, the bulb and beginning of the membranous portion, 216=67 per cent.

The strictures always develop very slowly. Thus, Thompson gives the period of development among 164 cases in

10 cases during the acute blenorrhœa.
71 " 1 year.
41 " 3 to 4 years.
22 " 7 to 8 "
20 " 20 to 25 " after the termination of the urethritis.

This affection, which belongs to the field of surgery, has been the subject of such excellent, in part monographic, treatises that we will not consider it here.

Chronic Urethritis of the Pars Prostatica.

Like the preceding form this runs a latent course in many cases. The clap shreds, which are produced only in the inveterate cases, remain deposited in the pars prostatica, and are discharged during micturition with the first urine. Nevertheless prostatic urethritis presents some variations in symptomatology which not infrequently permit us to ascertain its situation. This is true of the more recent form, with production of mucous secretion in addition to the clap shreds. If this mucous secretion is produced abundantly, as happens not infrequently during the night, it is discharged into the bladder, especially when the latter is considerably distended, and then causes cloudiness of the second urine. The diagnosis of chronic prostatic urethritis is therefore favored by cloudiness (usually of a slight grade, which makes the impression as if the glass vessel, into which the urine was passed, is "sweating") of both portions of the morning urine, in addition to flocculi in the first urine. Another circumstance must be taken into consideration. The mucous membrane of the pars prostatica is rich in glands, which are enclosed in the prostate, and empty on both sides of the caput gallinaginis. The inflammation generally extends to the excretory ducts of these glands, and they become occluded by a plug of mucus, pus and epithelium, which has the appearance of a comma. Unlike the clap shreds, which are deposited on the mucous membrane, these quite firmly adherent plugs are not washed away by the first stream of urine. They are expressed by the contraction of the compressor muscles, which shut off the bladder and squeeze out the last drops of urine from the pars posterior, and they are therefore found in the second urine. A second, slightly mucous, cloudy urine, or the presence of hook-shaped and comma-shaped clap shreds in the second cloudy or clear urine, testifies in favor of chronic prostatic urethritis. If it is confined to the mucous membrane, it usually presents no subjective symptoms.

The process is essentially different and much more serious

when the inflammation extends deeply, beyond the mucous membrane. In the pars prostatica the mucous membrane passes over the prostate, an extremely complex organ, which is very rich in nerves and glands, is intimately related to the sexual organs, in its developmental history is analogous, in a certain sense, to the female uterus, but belongs to the uropöetic system on account of its muscular tissue. Extension of the chronic inflammation, at first to the caput gallinaginis and the glands of the prostate, then to the prostate itself, produces a severe form of chronic urethritis. Irritative symptoms of various kinds set in, and affect the secretion of urine as well as the sexual sphere and nervous system.

Tenesmus occurs as a disturbance of urinary secretion. In some cases this is manifested merely by somewhat more frequent desire to urinate; the patients simply imagine that the capacity of the bladder has diminished.

In other cases the feeling of increased desire to urinate is provoked by other functions, especially defecation and coitus. After each defecation, especially if the passage of firm fecal masses has exercised strong pressure on the prostate, the patients experience a more or less violent desire to urinate, which cannot be satisfied, inasmuch as the bladder was emptied during defecation. This desire lasts until urine has again collected in the bladder and has been discharged, whereupon it ceases at once. In other cases the patients are compelled to urinate two or three times at short intervals before the tenesmus ceases. It may be produced by examination per rectum and pressure above or upon the prostate.

In some patients annoying, but not violent, tenesmus occurs after coitus or pollutions, but ceases after the patient has micturated one or more times at short intervals.

In addition, there are usually irritative symptoms in the sexual sphere. The patients often complain that the feeling of pleasure during coition is lost. Or they complain of a more or less violent darting pain in the back part of the urethra or the rectum, which occurs at the moment of ejaculation and drowns the feeling of pleasure. The form of impotence known as irritable weakness, is also very frequent. The patients have good erections and the sexual excitement is present, but this causes premature discharge of semen, which occurs before immissio or immediately after the beginning of coitus. The

erection then subsides at once and a long time elapses before a new one develops. Pollutions are also a frequent complaint of the patients, who experience a coincident diminution of potency.

These patients are very often frightened by another circumstance. They often tell us that they suffer from an escape of semen. On closer inquiry it is learned that with each defecation, especially if difficult, the patients notice the escape of a cloudy, thickish, mucous fluid which they regard as semen. Pressure on the prostate through the rectum discharges the same secretion, which is shown by microscopical examination to be the product of the prostate in a condition of catarrhal inflammation (prostatorrhœa)

Other patients really suffer from spermatorrhœa, but it usually remains latent. Not very infrequently a few spermatozoa can be found in the urine of patients suffering from chronic urethritis. They are found occasionally in prostatorrhœa, but their number is small. In other cases semen is discharged in abundance during micturition and defecation—micturition and defecation spermatorrhœa. Fuerbringer regards this as the result of evacuation of the seminal vesicles by pressure, the ejaculatory ducts being relaxed at the same time by the chronic blenorrhœa. In a case of profuse defecation-spermatorrhœa from chronic urethritis in a man of thirty years, I observed the discharge of exclusively motionless spermatozoa, in addition to impotence and complete absence of erections.

With the implication of the caput gallinaginis, an organ extremely rich in nerves, is produced a series of morbid nervous phenomena, which are manifested by increased irritability and exhaustibility of the nerves, and is known as sexual neurasthenia.

The functional sexual disturbances which we have already mentioned also belong to the domain of neurasthenia. In addition there is an entire series of nervous disturbances which are partly localized, partly of a spinal nature, and in part are manifested by general nervousness and neurasthenia. The local nervous disturbances include hyperæsthesiæ, paræsthesiæ and paralgiæ in the urethra. During micturition the patient experiences a feeling of heat or burning in the urethra, which makes him think of an inflammatory process in the canal, or

sometimes pains and darts in the urethra appear spontaneously. Many patients complain particularly of a dull painful feeling, as if the penis were constricted in the region of the urethra. The hyperæsthesia is not infrequently so great as to produce reflex spasms of the compressors. The urine is then ejaculated by jerks in a thin stream, and gives rise to the notion of a stricture. Introduction of a sound into the urethra produces spasmodic contractions, especially of the compressors. The painful sensations also radiate into the distribution of the plexus sexualis, along the spermatic cord and into the testicles (partly as dull pressure, partly as lancinating pains), and also into the perineum and the anal opening. The latter in particular is not infrequently the site of hyperæsthesia and reflex spasms. The latter are often so violent that digital examination per anum becomes impossible. In other cases the anus is the site of an intolerable pruritus which is either continuous or paroxysmal. The scratching induced by the pruritus gives rise to eczema. Frequent eruptions of herpes on the glans, prepuce and integument of the penis also annoy the patient. These develop spontaneously or follow sexual excitement, coitus or pollutions. The general condition always remains good, the appearance and nutrition may be excellent. Nevertheless the patients are usually in a deplorable state. The impotence and pollutions depress the mind, the various sensations rouse the belief in some serious disease which is concealed by the physician, the mood is gloomy and hypochondriacal. This is especially true when the nervous disturbances spread farther, and other spinal symptoms are added. These include the various manifestations of spinal irritation, pressure and pain in the back, formication, cold or heat along the spine, radiating neuralgias and paralgias, particularly in the lumbosacral plexus. The neurasthenic symptoms may also spread farther. Digestion then suffers, symptoms of gastric and intestinal catarrh set in, but are only the result of atony. These reduce the patient, and his condition is thus aggravated materially. The nervous symptoms become more severe. There is general depression, pressure in the head, mental obtuseness, palpitation of the heart, etc. The unstable vasomotor system causes rapidly changing color, pallor and redness, especially in the face. Digestion is poor, the local symptoms in the domain of the uropoëtic and sexual organs attain con-

siderable intensity—no wonder that not a few of these patients terminate their existence by suicide.

SECRETION.

We have already described the various forms under which the inflammatory secretion appears in chronic urethritis. This secretion may appear in the form of a drop, or it is so slight or is produced so deep in the urethra, that it cannot escape, and is then found in the urine in the shape of shreds.

If it escapes from the urethra as a drop, its microscopical appearances are like those of the pus in the terminal stage of acute urethritis. We then find multi-nuclear pus cells, either singly or arranged in small groups, and various transition forms of epithelium, round, polygonal, spindle-shaped and caudate cells with a large nucleus. In addition large uni-nuclear flat epithelium and cylindrical epithelium cells are not infrequent.

These cellular elements, agglutinated by finely granular mucin, are found more frequently in the urine (Plate III., Fig. 8) as clap threads than in the form of drops. Microscopically we may distinguish two varieties or extremes of these clap shreds. They may be narrow, mucous, delicate and transparent, often very long and branched shreds, which consist of a good deal of mucus and few cellular elements, or they are shorter, firmer, whitish threads, in which the cellular elements predominate. The proportion of epithelial and pus cells varies. In the first-mentioned form the epithelium predominates, in the latter the pus cells. Mucous threads with much epithelium are a more favorable prognostic sign than short shreds with much pus.

The shape of the shreds varies, but does not permit any conclusion with regard to the situation or intensity of the process. Produced upon the diseased mucous membrane and adherent to it, they are separated by the stream of urine and carried away. In addition we find not infrequently short, comma-like, punctate, usually firm flocculi. These come from the excretory ducts of the various glands and follicles, and, when present in large numbers, are significant of a more intense implication of the urethral glands and therefore of a severe process. As we have previously remarked, these comma-

like shreds, which are found in the second portion of the urine and are formed in the glands of the prostate, are signs of chronic prostatic urethritis. Their structure is usually characteristic. They are composed of two superimposed layers of cylindrical cells. The upper layer, consisting of large cells, sends processes into a mosaic of small, almost round epithelium cells (Fuerbringer, 1883).

The microscopical appearances of prostatorrhœa are essentially different. Aside from the negative condition of absence of spermatozoa or their presence in small numbers, we find in the prostatic secretion numerous pus cells, polygonal and cylindrical epithelium, more rarely the double layer of cylindrical epithelium of the excretory ducts, laminated amyloid bodies, lecithin granules, and finally Boettcher's characteristic "sperma crystals." These are needle-shaped and whetstone-shaped crystals, discovered by Schreiner (1878), which consist of a salt of phosphoric acid, are peculiar to the prostatic secretion, and give the characteristic odor to the latter and to the semen. In order to demonstrate them, the secretion of the prostatorrhœa must be examined pure, and in particular it must be kept free from admixture with urine. To a drop of the prostatic secretion is added a drop of a one per cent. solution of ammonia phosphate, and the mixture allowed to dry slowly under the cover glass; very beautiful crystals then form.

An important question is that of the presence of gonococci.

These are found so constantly and exclusively in acute gonorrhœa that their absence from an acute purulent secretion of the urethra excludes blenorrhœa unconditionally. The conditions in chronic gonorrhœa are not so favorable. Their number is small, they cannot always be found, and in addition other, in part similar, micro-organisms are also present.

We may often examine the clap shreds or pus drops of chronic gonorrhœa for several days without finding any. Or we find occasionally one or a few pairs, isolated in cells. The question then remains an open one, whether they are situated in or upon the cells, since this can only be decided when a large number of cocci fill the cell, without projecting beyond the cell contour.

When one or a few cocci and a large cell cover one another in the field, the question cannot possibly be answered, as a

rule, unless the examination is made in a current of fluid and the cell has a rolling movement. I therefore distrust *à priori* the statement made by Lustgarten and Mannaberg (1887) that they had seen cocci similar to gonococci in the normal urethra within the cells. But one circumstance always characterizes the gonococci; they take part in the exacerbations of the process to which they have given rise, by increasing in numbers. It happens not uncommonly that the secretion is examined for several days, and various bacilli and cocci, also diplococci, but no sufficiently characteristic gonococci are found. Then follows an exacerbation. At once the gonococci appear in the more abundant pus, and, in particular, we detect the characteristic pus cells, which are filled with numerous pairs of cocci. At the same time, the other forms of bacilli and cocci have disappeared as if by magic. The question is therefore justified whether the micro-organisms which are found in chronic urethritis, and which are, in part, identical with those found by Lustgarten and Mannaberg in the normal urethra, can vegetate in the blenorrhagic, inflamed and suppurating urethra. The question is open, but according to the views mentioned above, it may be answered in the negative, particularly as the pus is always found free from micro-organisms in chemical or traumatic suppurations from the urethra.

In order to convince ourselves of the presence of gonococci in the secretion of chronic urethritis it is only necessary to induce an exacerbation or relapse. The patient himself often does this. In other cases the physician stimulates the secretion for purposes of diagnosis. It is sufficient to inject, by means of Ultzmann's injection catheter, a few drops of a ½ to 1 per cent. solution of silver nitrate in order to secure suppuration, which generally contains gonococci in abundance. In order to avoid confusion with other micro-organisms Neisser irrigates the urethra several times with a solution of corrosive sublimate (1:20000). An irritation develops and gives rise to suppuration and desquamation of the upper layers of cells. With the latter are removed the accidental micro-organisms adhere to them, while the gonococci, which proliferate in the tissues, remain intact and appear in increased numbers in the pus of the next few days.

Nevertheless there are cases in which, despite repeated examinations for several weeks and despite one or more artificial

exacerbations, no positive results with regard to the discovery of gonococci can be reached. In these cases we must arrive at the conclusion that the gonococci have perished, but that the changes produced by them continue to develop. The secretion then contains, as a rule, no pus cells, but numerous epithelial cells, and, in addition to other inconstant bacterial contaminations, in some cases narrow, short bacilli often arranged in short chains upon the cells (Plate IV., Fig. 11). We therefore have to deal no longer with suppuration but with epithelial desquamation.

This is either the result of a process which has run its course, the epithelial thickening, or of increased epithelial desquamation due to a micro-organism, but not of the blenorrhagic process.

We have already said that, in addition to gonococci, other bacteria are found in the chronic cases. These are not constant. There are always a large number of blenorrhœas in which we find no gonococci or other micro-organisms. Then there are others in which, even in the terminal stage of the acute urethritis, various micro-organisms are found in addition to the gonococci, and this is also true of chronic gonorrhœa.

The micro-organisms are mainly bacteria, more rarely cocci. The former include short and broad, narrow and long, or slightly curved comma-like forms which are found in short chains or groups usually free between or upon the cells. The cocci may be small and arranged in short chains or groups of chains, or somewhat larger diplococci about the same size as gonococci, or large spherical cocci in short chains; finally zoöglœa forms (Plate IV., Fig. 9). Almost all of these are found in groups, free, and although one group or another, lying upon a cell, creates the impression as if situated within it, the demonstration of groups which constantly project beyond the contour of the cell, proves that the micro-organisms are situated externally. Their small number and the coincident occurrence of several varieties in tolerably equal numbers prove their accidental character. Artificially produced and notable suppuration always causes their immediate disappearance.

I could never detect any gonococci or other micro-organisms in the secretion of prostatorrhœa, despite numerous investigations.

The question of the occurrence of gonococci in chronic clap is associated with another important question, *viz.*,

The Infectiousness of Chronic Gonorrhœa.

This question was answered differently at different times. Kuehn (1785) believed that when the secretion lost its purulent character, the danger of infection was gone. Hunter, B. Bell, Sallaba, Girtanner, Baumès and Ricord denied the infectiousness of an after-clap. On the other hand, Rossen, Simon and Geigel warned against trusting even the oldest clap. Gosselin denies the infectiousness, while Milton reports several cases of infection by the secretion of old chronic urethritides. Neisser (1884) was the first who studied the subject scientifically. He proved that the infectiousness of chronic blenorrhœa is a conditional one, in so far as the secretion may contain gonococci, that there are cases in which the secretion only contains the cocci at times, and finally others which are always found to be free from gonococci despite the most careful and frequent examinations. Furthermore, since the secretion is small in amount, and after being washed away by the urine requires a considerable time for its regeneration, it follows that a single act of coitus with an individual suffering from chronic blenorrhœa does not necessarily produce infection. As the result of numerous examinations I concur in this opinion and permit a patient who is suffering from chronic blenorrhœa, *i.e.*, the morning drop or clap threads, to have marital intercourse only after I have convinced myself by a two to four weeks' daily examination of the secretion or clap shreds that these contain only epithelium and no pus cells, and when, after irrigation of the urethra with a solution of silver nitrate or corrosive sublimate and consequent suppuration, the secretion is entirely free from gonococci, and there is no further indication for the continuance of treatment.

Localization.

We have just described the various forms of chronic urethritis and their symptoms. But it would be wrong to infer that it always runs its course according to the type of one of these three forms. There are pure cases in which only one of

the parts mentioned is the site of the process, but there are also mixed forms. In general it may be said that chronic urethritis of the bulb is the most frequent variety, but prostatic urethritis is not rare. Among 103 cases Guyon found the bulb affected 74 times, the pars prostatica 29 times. Not infrequently the bulb and pars prostatica are both affected, or the process extends from the bulb into the pars prostatica, either continuously or in patches, which leave free only small intervening spots.

An approximate localization is possible from the consideration of the symptoms and examination of the urine. Thus, a discharge from and agglutination of the meatus, indicates anterior chronic urethritis of the pendulous and bulbous portions. Mucous cloudiness of the second portion of the morning urine, comma-like flocculi in the second portion, prostatorrhœa and neurasthenic symptoms favor the diagnosis of prostatic urethritis. But these symptoms are not conclusive, and their absence does not exclude the localization in question. Thus, there may be a mild posterior urethritis in which the mucus does not enter the bladder on account of its small quantity and in which the glands are not implicated, so that no comma-like shreds are found in the second urine. The process is superficial, therefore no affection of the caput gallinaginis, no neurasthenic disturbances. Hence, if we confine ourselves to an examination of the patient, we will overlook the process in the pars posterior. This remains untreated, therefore becomes aggravated and finally leads to severe symptoms, which could have been obviated by early treatment. Hence the attempt was made at an early period to determine the site of chronic urethritis more accurately. Leroy d'Étiolles introduced into the urethra as far as the bulb a bougie which carried a small hidden sponge at the end. The sponge was then exposed and the bougie withdrawn, so that the pars anterior was cleansed. An ordinary bulbous bougie was then introduced into the pars posterior. If mucus or pus adhered to the tip, this could only come from the pars posterior. The following is Zeissl's method: The patient, who had not urinated for several hours, received an injection of pure water into the pars anterior in order to wash away any flocculi contained therein. After the water, which at first contains shreds, escapes clear, the patient is allowed to urinate. If the urine then contains shreds, they

must be derived from the pars posterior. A better plan than that of injection with the clap syringe, as performed by Zeissl, is that of inserting an elastic catheter as far as the bulb, performing recurrent irrigation of the pars anterior, and then allowing the patient to urinate.

The French, especially Guyon, Jamin, Guiard, use a bulbous sound, "sonde exploratrice," with which they first remove the pus from the pars anterior by rotatory movements and repeated introduction, and then pass into the pars posterior. If mucus or pus is then found on extraction, the process is situated in the pars posterior.

A frequently used method, which is based on the fact that the locus morbi in the urethra is sensitive and painful, is examination with the sound or bulbous bougie. If this is introduced slowly into the urethra, the patient not alone feels pain, which always results from the examination and is felt particularly in the membranous portion, but he not infrequently describes a burning or stitch pain in certain fixed points. If the examination has been made several times, and the pain is always localized in the same parts, we will hardly err in regarding these spots as the site of urethritis. If the process is localized in the pars prostatica the passage of this part usually causes a violent, painful tenesmus, and the withdrawal of the sound is followed by the prostatorrhœic secretion. In cases of urethral hyperæsthesia in neurasthenics sounding is very painful. The sound is arrested every moment by spasm of the urethra, passage of the membranous portion is arrested by the spasm, which only subsides at the end of a few minutes, and even the removal of the sound is made difficult from the same cause.

Although examination with the sound only informs us concerning the site of the disease (and this not very reliably), it possesses one advantage over the other methods. If the sound has the largest possible calibre which the meatus will admit, the examination proves that there is no notable narrowing of the urethra.

But the orifice is always the narrowest part of the canal. Hence slight stenoses may develop, which nevertheless permit the passage of a sound that can barely pass through the meatus. These strictures grow tighter in time and become noticeable when they have reached a smaller calibre than the

orifice. Otis calls these wide strictures and believes that there is no chronic urethritis without some, though perhaps slight, narrowing. These stenoses do not always deserve the name stricture, inasmuch as they have not developed from connective-tissue retraction but from infiltration and swelling of the mucous membrane. It is nevertheless certain that even connective-tissue strictures, in their incipiency, may escape our knowledge. Otis and Weir recommend the use of their urethrometer in order to recognize these wide strictures. If it is introduced into the urethra as far as the pars prostatica, the calibre dilated to 30 Charrière, and it is then withdrawn, we must usually bring it down to 27 Charrière on its entrance into the membranous portion. But if the membranous portion contains a beginning stricture, this will hold the olive and, according to its calibre, will only be permeable after reducing to 26 or 25. Immediately after passing through this part, we may return to the former calibre. In a like way the olive can be opened to 30 or more in a normal pars bulbosa, while wide strictures of this part prevent the passage of more than 29, 28, or 27. For more than two years I have examined almost all chronic urethritides with the urethrometer and in many cases found no wide stricture. Hence, I oppose Otis's view that there is no chronic urethritis without narrowing. Beginning strictures can be recognized much earlier by this method.

All these methods give us the situation of the chronic process, but not a picture of it. This can only be obtained by the use of the endoscope, which is often indispensable for diagnosis.

The notion of examining the mucous membrane of the urethra by means of apparatus similar in principle to the vaginal speculum, dates back to the beginning of this century. But the instruments inserted in the urethra have such a narrow lumen and permit the entrance of so little light, that concentration of the rays of the source of light and their reflection in the tube of the endoscope, were made necessary. Segalas was the first who grasped this idea, but Desormeaux was the first to execute it completely. He also founded the pathology of chronic urethritis in a manner which left little to be changed.

Desormeaux's instrument (Fig. 17) consisted of a funnel-

shaped urethral tube, at the end of which was fastened the illuminating apparatus. This consisted, in principle, of a perforated reflector, placed obliquely in a tube, and which received its light from a lamp placed on one side, while the eye of the observer looked through the central opening in the mirror. Apart from the weight of the instrument it possessed the disadvantage that it was adapted for study but not for local interference. After a series of changes had been made in the source of light, others made more material changes, the most important of which is the complete separation of illuminating

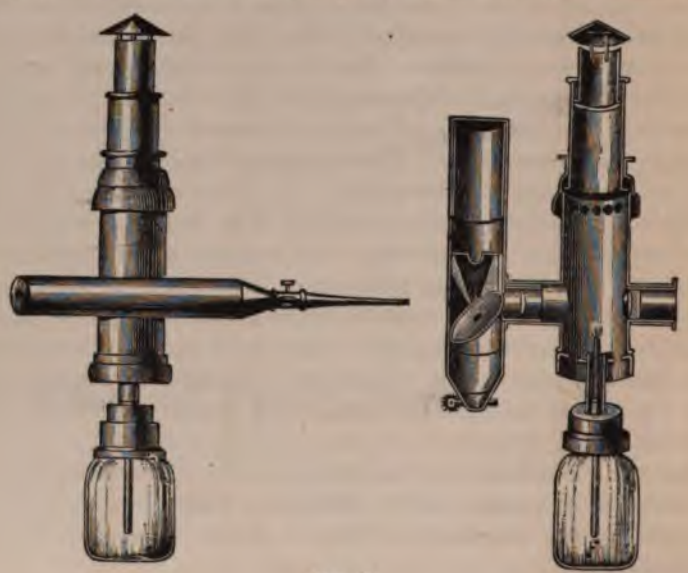

FIG. 17.

apparatus, reflector and tube; this was first conceived by Hacken. Gruenfeld used for illumination a gas or oil lamp, as reflector a laryngoscopic mirror which can be fastened to the forehead, and a series of endoscopic tubes (Fig. 18), long and short, fenestrated anteriorly or laterally, and with the fenestræ either open or closed with plane glass, destined for various parts of the urethra and bladder. Steurer's modification (1876) was a practical improvement of the endoscopic tubes. The Gruenfeld tubes, with a calibre of catheters of 18 to 24 Charrière, pass gradually at the ocular end into a tolerably wide funnel, which is blackened inside like the endoscope, and whose

serrated rim serves for the conduction of the instrument. The introduction of the instrument into the urethra to such a distance as to cause painful distention of the meatus by the funnel is almost unavoidable. Steurer uses shorter tubes (Fig. 19), which render better illumination possible, and then inserts a round plate into the tube at the point where it passes into the funnel. The fixation and conduction are thus facilitated materially, while the plate permits the painless shoving together

Fig. 18.

Fig. 19.

of the penis in examination of the deeper parts and thus the use of shorter tubes. In order to make larger parts of the urethra visible, Auspitz (1879) recommended a bi-valve endoscope (Fig. 20), which is inserted with the conductor closed and is then opened, and, being formed after the manner of Cusco's duck-bill speculum, does not distend the orifice. Instead of the ordinary rounded conductors which project slightly beyond the tube, Schuetz (1886) uses an olive-tipped bougie, which is introduced into the posterior portion of the

urethra, and over which the endoscope is inserted. Posner recommends tubes which are bright inside, like Ferguson's speculum, instead of blackened tubes. In order to see larger surfaces of the pendulous portion, Autal devised his aëro-urethroscope, a short endoscopic tube which is applied firmly to the glans by a sort of cap, and is closed above by a glass

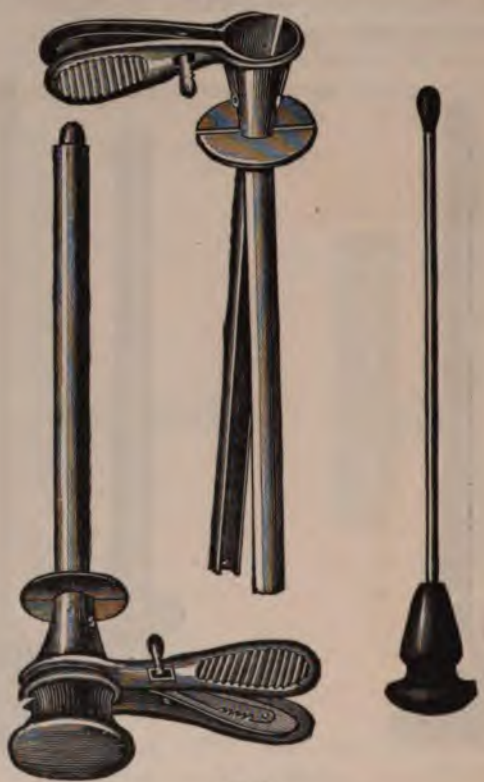

FIG. 20.

fenestra. By means of a bulb on the side of the tube air is blown into the urethra and separates its walls, and thus permits a view of a larger area, which is always anæmic from the pressure of the air. Gruenfeld also mentions a method of auto-endoscopy for the benefit of specialists who may be suffering from chronic urethritis.

The introduction of electric lights has led to the construction of new apparatus—for example, Oberlaender's modifica-

tion of Nitze-Leiter's instrument. This consists of endoscopic tubes, but the source of illumination, a white-hot platinum wire, is situated at the visceral end within the tube. In order to prevent the conduction of heat from the wire to the instrument and mucous membrane, a thin column of fluid flows around the wire. Although made very compactly the apparatus nevertheless narrows the lumen of the endoscope, apart

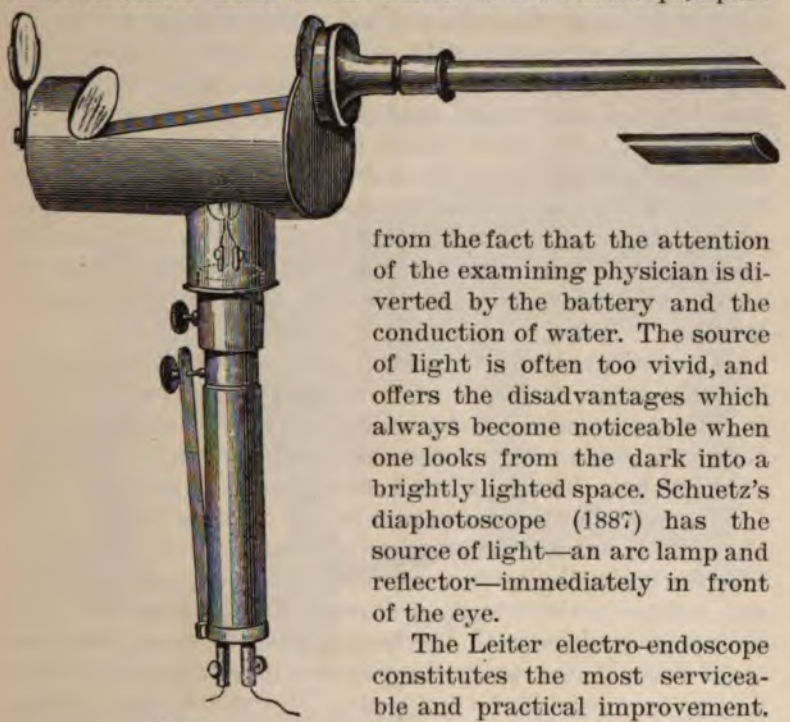

Fig. 21.

from the fact that the attention of the examining physician is diverted by the battery and the conduction of water. The source of light is often too vivid, and offers the disadvantages which always become noticeable when one looks from the dark into a brightly lighted space. Schuetz's diaphotoscope (1887) has the source of light—an arc lamp and reflector—immediately in front of the eye.

The Leiter electro-endoscope constitutes the most serviceable and practical improvement. This returns to the principle of the Desormeaux endoscope. It consists of short endoscopic tubes, fashioned after Steurer's, at whose ocular end is applied the easily-handled illuminating apparatus by means of its funnel-shaped end. The illuminating apparatus (Fig. 21) is connected by two wires with the battery, and consists of an arc lamp and behind it a fixed concave mirror, which throws the rays of light parallel into the funnel and through those into the endoscope. The eye of the observer looks over the rim of the mirror into the funnel, and tampon, brush and other instruments are introduced in the same direction. The vivid-

ness of the illumination may be varied by raising or lowering the elements in the cells.

Technique of Endoscopy.—At the present time we use only short straight tubes, like those recommended by Steurer. The introduction of the straight instrument into the urethra is attended with some difficulty for the beginner. The well-oiled instrument should be led along the upper wall of the urethra as far as the bulb, but not pressed too far into it; the ocular end is depressed, with coincident slight pressure upon the visceral end of the instrument, in order to enter the isthmus, and then the instrument pushed forward to the neck of the bladder, *i.e.*, until urine begins to escape between the instrument and conductor when the bladder is moderately full. Slight traction now brings the apparatus immediately in front of the internal prostatic sphincter. The examination of the urethra is always conducted from behind forwards, the conductor being removed and the field of vision cleaned with tampons.

The patient should be placed upon a table (Fig. 22) which is at the level of the eye of the physician sitting in front of it. For examination of the neck of the bladder and pars prostatica the ocular end of the instrument must be depressed considerably. The patient's genitalia must be raised in order to see well. For this purpose it is well to have the lower end of the table movable at an angle by means of a screw. Small drawers under the table, containing tampons, caustic-holders, etc., render assistants superfluous. The patient lies in the horizontal position with the head slightly elevated, the lower limbs flexed and kept in the position most agreeable to the patient by means of the foot rests. The best tampon-carriers are little rods of wood, which can be obtained in match factories. A little cotton is wound firmly around one end and the rod thrown away after being used once. Very serviceable tampon-carriers are also made of firmer iron wire, the visceral end, around which the cotton is wound, being filed down and slightly serrated. After using the cotton is burnt in a spirit lamp, thus securing at the same time the best sterilization of the wire.

In examining the normal urethra we notice, in the posterior portion of the pars prostatica, that the mucous membrane passes from the rim of the endoscope to a quite centrally situ-

ated point, in which it comes together like a sphincter and thus forms a short funnel. The color of the mucous membrane is quite dark red, its surface smooth or slightly ridged by delicate longitudinal folds, which all pass towards the apex of the funnel, and are called the "central figure."

As the endoscope is withdrawn the mucous membrane at the apex of the funnel follows, so that the funnel always remains the same. At the same time we notice a gradually increasing pallor of the mucous membrane. If we withdraw the tube a little, we will notice that, while the funnel remains intact above and laterally, a flat, or round protuberance pushes

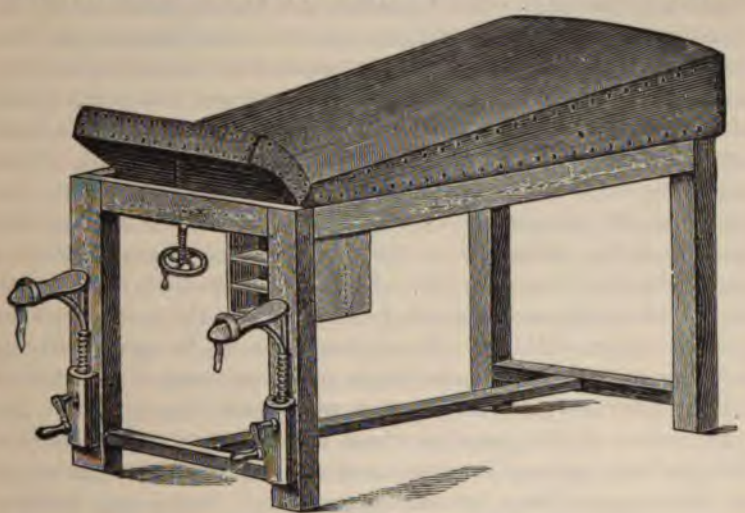

FIG. 22.

into the lumen of the endoscope from below or often from below and on the left side, and becomes clearly visible on withdrawing a little further. This is the caput gallinaginis, which has a quite uniform carmine color and occupies about three-quarters of the field of vision. To the right and left are two dark furrows; above it the funnel, which is reduced to the shape of a crescent. In favorable cases, especially if the caput is brought entirely into the lumen by lifting the ocular end of the tube, we see upon the prominence the opening of the pocular, like the point of a needle.

On further withdrawal the caput gallinaginis passes backwards, but its prolongation remains visible for a considerable

period as a large fold on the lower surface of the funnel. In consequence of the projection of the caput gallinaginis, the central figure forms a short curve, with the convexity above, the concavity below and a little to one side, and which grows constantly smaller from behind forwards. Finally we arrive at a point where the mucous membrane, which gradually grows paler, again forms a complete funnel with punctate central figure, and the mucous membrane is smooth or slightly ridged radially towards the central figure. We are then in the membranous portion. So long as we remain there, the appearance of the short, pale-red funnel is the same. Next follows a spot, which may prove especially confusing to the beginner. On continuing the slow withdrawal we leave the membranous portion. As soon as we are out of the isthmus, the visceral end of the endoscope enters the field of activity of the bulbo-cavernosi and ischio-cavernosi muscles, which push it upwards with rapid contractions. In order to counteract this movement, which may even expel the instrument if held too lightly, it is sufficient either to lift the ocular end and to carry on the further conduction of the endoscope in the same way as a catheter (in a curve directed towards the abdominal walls), or the visceral end of the instrument must be kept below the symphysis by pressure from without. The action of the bulbo-cavernosi and ischio-cavernosi muscles is visible in the endoscope. The funnel hitherto formed by the mucous membrane disappears. The contraction of the muscles which are situated on the sides of the urethra, pushes the mucous membrane into the endoscope in the shape of two lateral ridges, which touch in a vertical fissure in the middle of the field of vision. This picture persists throughout the entire pars bulbosa, except that the vigor of the muscles, and hence the width of the ridges, diminishes anteriorly. In this situation the color of the mucous membrane is subject to the greatest variations; it may be entirely anæmic as the result of pressure, but is normally of a pale flesh red. On careful examination of one or the other wall we can see not infrequently the Morgagni's lacunæ as dark spots surrounded by a narrow ring of darker red mucous membrane.

On passing into the pendulous portion the funnel of the very pale red mucous membrane again appears. This funnel is so much longer the more the pars pendula is stretched, and in this way a large portion of the mucous membrane may be

brought into view. Radial folds are not infrequent, and Morgagni's lacunæ are often visible.

With regard to the appearances in chronic urethritis the endoscope possesses the great advantage that it allows us to recognize not alone the site of the changes but also their nature. The endoscopic picture is essentially the same in pathological cases as in the normal, but undergoes certain modifications from the swelling and infiltration of the mucous membrane. When it forms a funnel with a punctate central figure, the funnel will suffer in all its dimensions by the uniform succulent swelling, and will become narrower and shorter. If the swelling is very considerable, the mucous membrane will even project into the tube, and the funnel will start from this projection; it is therefore very small, narrow and low. If there is rigid, though uniform, swelling of the mucous membrane, the latter will not come in contact so rapidly, and the funnel will be longer and higher. Unequal, unilateral or disseminated infiltrations and swellings will make the funnel unsymmetrical; swollen folds appear distinctly and disturb the punctate shape of the central figure, which is distorted, oval, or formed of several contours which are convex internally. Where no funnel is formed, but the mucous membrane is ridged, as in the bulb, the ridges project into the tube to a greater extent if the swelling is succulent, but are not prominent if the swelling and infiltration are rigid. Indeed, it is found not infrequently that no ridges are formed, and the mucous membrane incloses the field of vision like the wings of the stage.

The changes in the surface consist, in the first place, of differences in color. Various shades from red to dark red and bluish red may be found diffused or disseminated in different parts of the urethra.

The surface may also appear changed, apart from the color. It may look smooth and shining in the diseased parts, but more frequently it has a dull look. In many cases it is seen that this dull appearance depends on epithelial losses, which give the surface a finely stippled appearance. Or the surface shows a velvety roughness. In still others it is cloudy, looks swollen, has lost the smoothness of normal mucous membrane, and is covered with a large number of dark-red grains, which may be uniformly of the size of small grains of sand, or they are unequal, with a pointed, conical or round top, and present

the appearance of a mulberry or a granulating wound. This change, known as granulation, may occupy large surfaces or appear as small, circumscribed patches. Certain circumscribed affections also occur, as swelling of Morgagni's lacunæ, with erosion of the vicinity of the excretory ducts, intense redness, irregular superficial ulcerations, and patches of thickened and opaque epithelium. Finally, in addition to the previously described granulations (which often attain considerable dimensions from loosening of the tissues and fungous proliferation), are found true trachomatous granules, which are succulent, and shine through the delicate mucous membrane like frog spawn (Gschirhakl, 1878; Gruenfeld, 1880).

We thus have a picture of great diversity, which is so much greater because all the changes mentioned may be present in the same urethra. But certain changes are found mainly in certain portions of the canal.

If we examine the urethra in these cases from behind forwards, we will find at the neck of the bladder, in addition to a very small, or, as the result of rigid infiltration, very wide and high funnel, that the mucous membrane has a deep livid redness, the folds which radiate from the central figure are more distinct, here and there (usually isolated) a larger erosion, which bleeds at once when touched with the tampon. In cases of chronic prostatic urethritis the caput gallinaginis is considerably swollen, the mucous membrane livid and velvety, and pressure with the tampon causes violent pain. The pallor of the remainder of the mucous membrane usually contrasts with the dark redness of the caput gallinaginis. I have never found granulations in the pars prostatica, but Desormeaux describes them.

In the membranous portion we usually find only swelling, redness and small erosions. Granulations occur not infrequently in the anterior portion, but their proper territory is the bulb, which they often fill in great measure. The pendulous portion presents the most manifold picture. Patches of granulations and thickened and cloudy epithelium alternate with simple catarrhal swelling, redness, and erosions.

For this reason it is inadvisable to divide chronic urethritis into urethritis simplex, granulosa, trachomatosa, etc. All the changes seen by us in chronic urethritis are phases of one and the same process, which may occur together or follow one an-

other. This is explained by the fact that the process has its sites of predilection to which it is chiefly confined and in which it reaches its highest development, while in other places it does not run such a severe course or is complicated by secondary changes.

Pathological Anatomy.

The nature of chronic urethritis, like that of the acute form, long remained obscure. Thus, Swediaur (1798) regarded the prostate as the site of gleet and the secretion as an unnatural discharge of the mucus of this gland. Girtanner (1803) regarded gleet as a weakness of the mucous glands.

Desruelles (1854) had the opportunity of making an autopsy on an old man who died of pleurisy and had suffered for twenty years from chronic urethritis. He found a number of yellowish-white granulations, which were situated mainly in the membranous portion; the remaining mucous membrane of the urethra was delicate, pale and thin. According to Civiale, his pupil Lewy had observed (1850), in an autopsy on a stricture patient, numerous fine, dirty gray granulations in the prostatic portion behind the stricture; but little attention was paid to these appearances.

Desormeaux (1865) described the appearances in chronic urethritis from his examinations in the living, and called especial attention to the granulations. As an adherent of Thiry's (1840) doctrine of a "virus granuleux," he regarded them as a characteristic not alone of chronic but also of acute blenorrhœa. In addition to red granulations, like those of proud flesh, Desormeaux described gray granules like those of trachoma.

Soon afterward Cullerier reported two autopsies on old urethritides. In the first case, a young man who had died of typhoid fever and was said to have suffered only thirty-three days from clap, there was dark-violet redness of the entire anterior part of the urethra, where the mucous membrane was thickened and rough. On the lower wall of the urethra, in the pars prostatica, he found about twenty small red nodules, surrounded by a circle of injected capillaries, exactly like the granulations found on the ocular conjunctiva. Similar changes were seen in another case of urethritis two months old.

Fauconnier was the first to furnish a detailed account of an autopsy in a man, æt. thirty-two years, who entered Guyon's wards on January 15, 1877, suffering from a chronic urethritis of seven years' standing and a recent syphilis. He died of facial erysipelas. Examination of the urethra (Plate V., Fig. 12) showed: at the neck of the bladder, near the caput gallinaginis, the mucous membrane was whitish, non-vascular, as if cicatrized. The caput gallinaginis was enlarged and thickened. Pressure on the ejaculatory ducts discharged prostatic secretion mixed with pus. In the membranous portion the mucous membrane appeared pale, smooth, like a cicatrix, and traversed by longitudinal vessels. The mucous membrane of the bulb is sharply defined posteriorly, while anteriorly over a surface of about 6 centimetres it is uneven, dull, eroded in some places, congested, covered with extremely fine, whitish granulations, which are especially dense in the bulb and resemble a granulating wound. The pars cavernosa is normal except a strongly injected portion anteriorly, about 5 centimetres long. No trace of narrowing or fibrous thickening in the entire urethra. Microscopical examination of the granulations showed small cell infiltration.

Soon after appeared two interesting examinations by Vajda (1882). In two cases of old chronic urethritis, in one of which a stricture and peri-urethritis were also present, he observed: 1. Thickening of the epithelium, attended with flattening, so that the cylindrical epithelium of the urethra finally disappeared entirely. 2. The newly formed epithelium masses are collected especially at the apices of newly formed hypertrophic papillæ and protuberances, which formed excrescences and finally papillomata. 3. The papillomata and epithelial thickenings increased in the deeper parts of the urethra. 4. The connective tissue around the urethra is infiltrated.

In the Atlas des maladies des voies urinaires of Guyon and Bazy are found two cuts of anatomical preparations of chronic urethritis. In one the urethra is normal as far as the bulb. Here the mucous membrane is congested and slightly excoriated, sharply defined posteriorly, but gradually merging anteriorly into normal membrane. In the second case granulations and small ulcerations are found in the bulb, but gradually disappear anteriorly.

In Gosselin's case, reported by Gueillot, the fossa navicu-

laris and the bulb were found affected. In the latter the mucous membrane was violet in color, traversed by dendritic vessels, which gradually disappeared anteriorly.

These investigations are insufficient to furnish a picture of the entire affection. We are especially in the dark concerning the termination of chronic urethritis. Can a chronic urethritis heal entirely spontaneously? What changes in the urethra does it leave? That ulcers may heal, and a passive congestion disappear completely, is not impossible. But can thickenings of the mucous membrane, granulations and trachoma nodules be absorbed? can epithelial deposits disappear? This we do not know. Stricture is a frequent termination of chronic urethritis. The anatomical examination reveals fibrous degeneration of the mucous membrane and of the submucous tissue as far as the corpus cavernosum. Whence does the stricture develop? Many attribute it to ulcerations. But deep ulcers, from which retracting cicatrices could result, are not found in chronic blenorrhœa, and superficial erosions cannot result in a retracting cicatrix. Many attribute strictures to the granulations, especially because the latter are found not infrequently in the vicinity of the stricture. Moreover, the site of the strictures, the bulb and beginning of the membranous portion, coincides with the favorite site of the granulations. But granulations are also found in the pars prostatica, in which a stricture is never situated. On the other hand, it is an open question whether, as Auspitz believes, the granulations alone, *i.e.*, the process of swelling and proliferation of the mucous membrane, and conversion of the infiltration at first into soft, later into callous connective tissue, can form a stricture, or whether infiltration of the submucous tissue must also be present, as is rendered plausible by the appearances found on autopsy.

The finer structure of granulations is also unknown, especially whether they consist of granulation tissue, and develop directly from the mucous membrane or from pre-existing lymphatic tissue.

Finally, the relation of gonococci to chronic urethritis is extremely obscure. According to Bumm, relapses of acute urethritis are owing to the fact that the gonococci, in the last stage, push up from the deep parts through the new-formed epithelium, and are compelled to more superficial growth in the

uppermost epithelial layers. If no noxious influences intervene, the upper layers of epithelium, which contain the gonococci, are exfoliated and the process then appears to be ended.

At this time the inflammatory process is disappearing in the papillary stratum. But if any external morbific cause intervenes, the process undergoes an exacerbation. Extravasation of lymph fluid and pus cells occurs, and this fissures the compact epithelial layer. Through these fissures the gonococci again penetrate to the papillary body, and produce irritation with acute suppuration, *i.e.*, a relapse. The virulence of the gonococci is weakened by their long proliferation upon the same soil for many generations. As a proof we may mention the fact that chronic blenorrhœa is often conveyed as chronic, much more rarely as acute blenorrhœa. The fact that each succeeding relapse is milder and shorter also indicates that the irritation of the papillary body by the gonococci gradually diminishes. The first relapses will always terminate by the removal of the gonococci to the surface, but the virulence may finally be diminished to such an extent that the acute purulent symptoms on renewed invasion of the papillary body no longer suffice to carry the gonococci to the surface. They will then remain in the papillary body, perhaps also in the follicles, and by their constant slight irritation give rise to the chronic proliferating processes in the mucous membrane.

The conveyance of these enfeebled gonococci would explain the ab initio chronic infection in the female, and their proliferation in the deep layers enables us to understand the fact that gonococci may or may not be found in the secretion, the clap shreds.

But the chronic changes induced by the gonococci may develop further after the cocci have perished from any cause. This explains the fact that in certain chronic blenorrhœas we find the secretion and clap shreds but no gonococci. Perhaps certain changes which develop in the course of chronic blenorrhœa—for example, the formation of connective tissue, which gradually becomes more and more fibrous—may be the direct cause of death of the gonococci, and therefore we never find the cocci, at least in the secretion, in old blenorrhœas which are complicated by stricture. But this is pure hypothesis, which, although plausible, is lacking in demonstration.

Diagnosis and Differential Diagnosis.

The diagnosis of chronic urethritis is evident from its symptomatology, and we will refer, therefore, merely to a few factors which are especially important in diagnosis.

The most frequent symptom from which the layman makes the diagnosis is the "good morning drop."

But the presence of the drop is not a positive indication of chronic urethritis, nor does its absence exclude such a diagnosis.

A secretion which is characteristic, whether it appears as a drop or as the co-ordinate clap threads, must contain two morphological constituents. In the first place the secretion must contain pus cells. A secretion composed of epithelium alone is not blenorrhagic, although it may persist for a long time after the clap has run its course.

The gonococci are the second morphologically important element. We have described their characteristics and have also shown that they are not found constantly in chronic urethritis.

In this regard there are three possibilities: The gonococci may be present in such numbers and arrangement that they permit a diagnosis at once.

Or they are absent or present in such small numbers that doubt in the diagnosis is justified. More intense suppuration should then be produced by an injection of nitrate of silver or corrosive sublimate. This produces pus cells, enclosing characteristic cocci groups, and the diagnosis becomes clear.

Finally there are cases in which no cocci are found, even after profuse suppuration is produced. Nevertheless these may be cases of chronic urethritis from which the gonococci have already disappeared. The demonstration of the purulent nature of the secretion, the history of one or more previous urethritides, urethral examination with the sound and endoscope and the demonstration in this manner of a circumscribed chronic inflammatory patch, permit a diagnosis to be made even here.

If the question of the presence of blenorrhœa has been answered in the affirmative, then its acuteness is to be determined by the finding of mucus in addition to pus or the absence of the former. Cases in which in addition to the pus (drop or

clap threads) there is also mucous cloudiness of the urine, are the more recent, acute, less sharply circumscribed ones, in which, apart from the circumscribed chronic inflammation, there is also congestion and hypersecretion of larger areas of the mucous membrane. Those cases in which only clap shreds are found in otherwise clear urine are older affections, in which the process is sharply confined to one or a few diseased spots.

With regard to all these questions the morning urine is particularly to be examined.

We next consider the question of localization and the nature of the changes.

The symptoms which furnish data concerning the situation of the process have already been considered.

We first examine the second portion of the morning urine for mucous cloudiness and comma-shaped shreds from the prostate, phenomena that favor the diagnosis of chronic posterior urethritis.

Inquiry is then made for all those symptoms which usually accompany this form. Without putting any leading questions we often obtain important positive statements concerning prostatorrhœa, disturbances in micturition and the sexual functions.

If no data are obtained in this way, instrumental examination with the sound will furnish information concerning the location, with the endoscope concerning the nature of the changes.

When shall instrumental examination of the urethra be made?

According to my experience not until the process has really become localized. So long as mucous cloudiness of the urine is still present, the instrumental exploration should not be practiced. We must first combat the congestive condition which causes the secretion. If instrumental examinations are made at a time when the congestion and mucous secretion are still present, the increased inflammation is apt to convert the mucous secretion into a purulent one, which may last for weeks. More or less numerous gonococci are then usually found in the pus.

Exploration with the sound is the milder of the two modes of examination, and is therefore to be employed first. I agree entirely with Tarnowsky that the endoscope is to be used only

in those patients who have been examined several times with the sound and have become accustomed to the irritation. The latter often furnishes us with sufficient information concerning the site of the affection.

The endoscope is always absolutely indicated when a chronic localized blenorrhœa resists instrumental measures, and does not recover despite local treatment. Larger calibres are always to be recommended, and I never employ less than 22 Charrière. If the meatus is narrower I prefer to make the slight operation of division rather than to deceive myself and the patient with the uncertain results of examination with 18 or even 16 Charrière. Careful examination usually furnishes valuable information, and the discovery of the infrequent polypi can only be made with the endoscope.

From a differential diagnostic stand-point it must be remembered that not every drop which is squeezed out of the meatus is blenorrhagic pus. We must first ask concerning the appearance of the drop. The patient tells us not infrequently that the drop is as clear as water and is squeezed out in the morning, but agglutinates the meatus during the day. We then have to deal with a simple urorrhœa. It is a well-known fact that in erections, especially if protracted and vigorous, a drop of clear, stringy, sticky mucus escapes from the orifice (urorrhœa ex libidine of Fuerbringer, "suintement muceux" of Diday). This hypersecretion of a normal urethral mucus becomes permanent in individuals whose urethra is in an irritated condition from a previous blenorrhœa, habitual onanism or long-continued sexual excesses. This mucus contains very scanty formed elements, mucous corpuscles and epithelium, no pus cells, not infrequently a small number of various cocci and bacteria, but no gonococci.

Caution is necessary even if the mucus is colored and milky. The urorrhœa just described, especially if it follows an acute urethritis which has run its course, not infrequently makes the patient and physician believe in the continuance of the urethritis, and the necessity of treatment with injections, bougies, etc. The following state of affairs is then apt to happen:

The originally clear secretion becomes grayish, opalescent, then milky white. The cellular elements have increased in number, but consist only of epithelium, usually large rhombic

pavement epithelium, upon and between which are numerous micro-organisms, especially a short, narrow bacillus, arranged in chains (Plate IV., Fig. 11). Their number is so large that I interpret the abundant desquamation of the epithelium covered by them as an irritative phenomenon, and incline to the opinion that the micro organisms enter the urethra during the injections and instrumental measures adopted against the urorrhœa, or that they enter from the præputial sac. They proliferate upon the soil which has been alkalinized and so prepared by the urorrhœa, and then give rise to the increased desquamation as a slight irritative phenomenon.

This form of urorrhœa heals rapidly after a few injections of a weak solution of corrosive sublimate (1:4000).

The same form may also occur in connection with chronic urethritis.

The prostatorrhœa described by us occurs, although rarely, either after a cured acute posterior urethritis, especially if it was complicated by epididymitis, or in masturbators; it occurs alone or combined with sexual neurasthenia. Its demonstration, therefore, is not an absolute sign of chronic posterior urethritis. The prostatorrhœa, which is usually manifested only during defecation, must be associated with the symptoms of chronic urethritis, especially clap shreds containing pus corpuscles.

Finally, there is a rare form of prostatorrhœa which consists of increased production and discharge of normal prostatic secretion. Unlike the thick, muco-purulent secretion of prostatorrhœa due to chronic prostatitis, this is thin and milky, and is brought to light by pressure on the prostate per anum or by examination of the urethra with sounds of the highest possible calibre.

We have to consider one phenomenon, *viz.*, phosphaturia, ignorance of which is apt to cause great confusion. We not infrequently observe the following condition in patients under treatment for chronic urethritis. At one time or another when the patient evacuates his urine in two portions, we find the entire urine of a milky white color, with a shade of green. If the urine is allowed to stand, a white granular or finely flocculent sediment is rapidly precipitated. This sediment not infrequently leads to the diagnosis of vesical catarrh. On examination with the microscope (Fig. 23) it is found to consist

of phosphate and carbonate of lime, the former in amorphous, finely granular masses, the latter in wedge-shaped crystals, which are joined together into masses of sheaves and rosette shapes. The urine is feebly acid, neutral or feebly alkaline, thus increasing the suspicion of cystitis. But the diagnosis becomes clear, even without microscopic examination, on adding a few drops of acetic acid to the turbid urine, which clears it up. If carbonate of lime is present bubbles of carbonic acid form, but the phosphate of lime is dissolved without effervescence. This condition is explained by the insufficient

FIG. 23.

acidity of the urine, which does not keep the constituents mentioned in solution.

Phosphaturia is observed under the following conditions: 1. In acute and chronic urethritis, when the patient keeps too strict a diet and abstains for a long time from acid or salted food. 2. In chronic urethritis posterior and neurasthenia, belonging with polyuria to the symptomatology of neurasthenia as a secretory neurosis. 3. In acute and chronic urethritis when the physician recommends alkaline mineral waters, especially Giesshuebler and Preblauer water, in addition to strict diet, as is unfortunately often done.

Phosphaturia not infrequently runs an entirely latent course; in other cases, especially when phosphate of lime predominates in the sediment, the crystals cause burning during micturition and vesical tenesmus.

The condition is usually not permanent; cloudy urine alternates with clear urine. The morning urine is usually clear, the first urine passed several hours after meals is cloudy.

Ingestion of vegetable acids, also hydrochloric, acetic, or phosphoric acid, generally causes rapid disappearance of the cloudiness. Cantani recommends:

℞	Acid. lactic., ...	ʒ j.
	Aq. fontis, ...	℥ vj.
	Aq. menthæ, ...	ʒ ij.
	S. ℥ j in ½ glass of soda water every two hours.	

The cloudiness of phosphaturia does not interfere with the diagnosis of chronic blenorrhœa, because the opacity due to the presence of the lime salts disappears on the addition of a few drops of acetic acid. The urine either becomes perfectly clear and shows the shreds of chronic urethritis, or a mucous cloudiness, in the more recent cases, remains, in which the shreds float.

Prognosis.

A cautious prognosis is even more necessary in chronic than in acute urethritis.

The length of time in which the blenorrhœa will recover can never be foretold, nor can we even tell with certainty whether the disease will be cured at all. With the more rational basis for therapeutics the possibility of cure becomes greater, and the physician who is versed in the advances of recent therapeutics will cure a larger number of cases than one whose entire repertory consists of a clap syringe and thirty or forty prescriptions for endlessly varying injections.

But a certain proportion of chronic blenorrhœas remain intractable to all treatment. In the first place, because many patients do not regard the question seriously enough and because they are lacking in a quality which cannot be supplied by the apothecary, *viz.*, patience. Others are incurable because they are treated too much, are really maltreated.

There are two factors which impair the prognosis of chronic blenorrhœa. One series of cases do not become agrgavated, even though they may not be cured, but another series grow worse with the lapse of years, and present complications and changes which become more distinct with the duration of the disease—stricture in anterior chronic urethritis, prostatorrhœa and sexual neurasthenia in posterior urethritis.

In general the prognosis is more favorable in recent cases, less favorable in old, inveterate cases. It is more favorable in anterior than in posterior urethritis, because the former is more accessible to treatment, and stricture is a more easily treated complication than neurasthenia. The prognosis is also more favorable in those cases which have resulted from neglect of acute urethritis, more unfavorable in those in which the acute blenorrhœa had received various modes of treatment, and most unfavorable when the chronic urethritis itself has been the subject of varied, but usually unsystematic, therapeutic trials.

Finally, the prognosis is relatively favorable in those cases which, despite their long continuance, present neither stricture nor neurasthenic symptoms.

Treatment.

The same confusion is found here as in the treatment of acute urethritis.

The older physicians believed in the syphilitic character of chronic urethritis even more firmly than in that of the acute form, and the former was therefore treated with anti-syphilitic remedies if it did not yield within a certain length of time to copaiba, ptisans, and baths. We read in Fabre (1773): "Après tous ces remèdes, on saura à quoi s'en ténir sur le caractère de la maladie, et s'il faut en venir au grand remède pour la guérir, supposé qu'elle ne le soit pas."

On the whole chronic urethritis was neglected more often than at present, and only one sequel, *viz.*, stricture, received early treatment. Alexander Trajanus Petronius, of Castile, recommended cleansing the urethra with a wax candle or some similar instrument. The use of caustics in powder and ointments was also recommended, under the supposition that the stricture resulted from a caruncle or projecting spongy

growth. Wiseman, physician to Charles II., inserted a tube into the urethra as far as the stricture, and there applied a caustic, viz., red precipitate. Caustics were used so vigorously at that time that Astruc (1754) made a decided protest, and mechanical dilating apparatus was employed thereafter. Le Dran recommended catgut, Daran bougies, which were used by Fabre (1773), Kuehn (1785) and Hunter (1786). B. Bell pointed out the circumscribed site of chronic blenorrhœa and recommended bougies, which must be thick, because they act, in the main, mechanically by exerting pressure. Local astringents were also used. In obstinate cases Bell recommended that the bougies be smeared with turpentine or red precipitate ointment. Lallemand devised his porte-caustique in order to make localized cauterizations in the urethra and Mercier constructed a similar instrument. Both are short, curved catheters with a lateral fenestra, behind which is the caustic, which is at first concealed but is exposed by a twist.

Schuster (1870) recommended bougies of tannin and glycerine, which are introduced into the urethra, where they melt and act as astringents. Regnal and Lorey recommended gelatine bougies containing various solutions. Chiene (1876) injected into the urethra a paste of kaolin, oil and water. Walicki (1876) described an apparatus like a glove stretcher which is introduced, while closed, into the urethra, then opened, and used for blowing in powders. Zeissl made rods of kaolin and glycerine, which he inserted into the canal. Masurel injected a saturated solution of tincture of iodine in water. In obstinate cases of chronic urethritis Harrison (1885) even went so far as to draw off the urine by incising the membranous portion, and passing a silver cannula into the bladder.

All the injections to which we have referred in discussing acute urethritis have also been given in the chronic form, as well as the most varied internal remedies.

The local remedies and methods mentioned have all been recommended on a purely empirical basis, without any indication or accurate notion of their action. As they are introduced blindly into the urethra or after a preliminary exploration with the sound, it is never certain that they come in contact with the diseased surface. But they always reach healthy portions of the urethra and cause irritation. The action of the inert materials, such as kaolin, is purely mechani-

cal and irritating, and even the astringents possess merely a superficial effect.

Desormeaux had obtained some therapeutic benefits in cases in which he found a circumscribed lesion in the urethra, by fixing the endoscope in the canal, removing the illuminating apparatus, and applying medicaments through the tube. Or he inserted a lateral opening in the endoscopic tube for the introduction of a tampon, brush, and caustic-holder, and thus manipulated under the control of the eye. Tarnowsky also practiced treatment through the endoscope, and warmly recommends it. As the endoscope was improved, local manipulations were facilitated. Gruenfeld, Gschirhakl and Auspitz adopted endoscopic treatment, and Gruenfeld regarded it as the only rational method. But this is not true. Apart from the fact that the introduction of the instrument irritates the mucous membrane, and is apt to produce catarrhal symptoms on frequent application, all the manipulations performed in the endoscope, cauterizations as well as brushings, are directed only to the surface of the mucous membrane, and cannot affect infiltrations which are situated deep in the mucosa and in the submucous tissue. Just as in the treatment of trachoma the brushing with solutions of nitrate of silver and cauterization with copper sulphate in substance may cause disappearance of the granulations, but cannot prevent the formation of cicatrices, so the same manipulations in the endoscope may heal erosions and granulations, while deep infiltrations which may be present will run their progressive course and terminate in stricture.

Hence we also require methods which have a deeper action. B. Bell had recognized that the use of bougies depends chiefly on their pressure effects. But Otis was the first who, with the proper appreciation of the varying diameters of the different parts of the urethra, employed pressure in its full measure. He taught us how to measure the diameter of the normal urethra by means of the urethrometer, an instrument which also informs us concerning those beginning stenoses whose calibre is still greater than that of the meatus. Previous to Otis we were satisfied with passing those sounds which would just pass through the orifice. It is clear, however, that such a sound, for example, No. 24 Charrière, could show nothing if a part of the bulb is narrowed from 30 Charrière to 26, and

therapeutic action would also be imperfect. It is clear that a portion of the canal which originally had a calibre No. 30, could only be regarded as normal when it is again stretched to No. 30. This dilatation was hitherto prevented by the narrowness of the orifice. To the circumstance that strictures ceased to be treated when they reached the width of the external meatus is due the fact that the majority are merely improved, not cured, and that they relapse so rapidly.

Otis formulated the correct principle that the canal must be restored to its original calibre, and therefore employed sounds of large size, up to 30 or more. The resistance of the meatus to such a sound is removed by splitting it in the direction towards the frenulum. The little operation is a trivial one and heals rapidly. By successive increase of the size of the sounds, Otis heals beginning strictures as heretofore, except that he brings the canal to its normal dimensions or even beyond.

Oberlaender and v. Planner were not satisfied with this gradual dilatation, but independently devised dilators, with the aid of which they secured rapid distention and divulsion of strictures resulting from chronic infiltration. I do not concur in this method. So long as the infiltration is soft and succulent it will tear more easily, but when it is firmer and fibrous the mucous membrane will tear more readily than the infiltration, and I do not see what advantage such a rent in the mucous membrane, which must heal by new formation, will be in the recovery of the stricture. Apart from this we should avoid as far as possible making any wounds in the urethra which, according to Lustgarten and Mannaberg, contains pus cocci.

Starting from the theoretically correct and certainly practicable idea of the union of pressure and astringents, *i.e.*, of deep and superficial action, Unna (1884) devised his ointment sounds. He covers his sounds with a mixture of:

℞	Ol. cacao, ...	℥ iij.
	Ceræ flavæ, ...	ʒ ss.
	Argent. nitrat., ...	gr. xv.
	Bals. peruvian., ...	ʒ ss.

This mass, which is solid at ordinary temperatures, is liquefied in a lukewarm water bath, the sounds dipped in it and then hung up at the temperature of the room.

The warmth of the urethra melts the mass, and the nitrate of silver contained in it then acts upon the mucous membrane. Instead of the ordinary cylindrical sounds Casper uses sounds with six grooves, which terminate 5 cm. from the tip, and are intended for the reception of the ointment. In this way he avoids the passage of the ointment into the bladder. Appel and v. Planner, although they advocate this plan, observed irritative symptoms on the part of the urethra and bladder. Despite the good results obtained in many cases by this mode of treatment, I oppose it for the reason that the entire urethral mucous membrane is brought in contact with a strongly irritating 1 per cent. nitrate of silver ointment, and hence the healthy mucous membrane is irritated and hypersecretion induced.

I will now analyze those methods which I can recommend as the most useful, within the bounds of certain indications.

Apart from the localization we have recognized three forms of chronic urethritis:

1. The more recent forms in which, in addition to circumscribed foci, larger surfaces of the mucous membrane appear to suffer from congestion or passive hyperæmia. They manifest themselves by increased production of mucus, *i.e.*, by a cloudy, mucous urine associated with clap shreds.

2. Circumscribed, older forms, in which the changes are either superficial, in the mucosa,

3. Or are also situated in the submucous tissue. In accordance with this classification I will formulate a few sharply defined indications.

I. In the first form we must first combat the concomitant catarrhal symptoms, by applying dilute, feeble astringent solutions to the catarrhal portions, so that only the deeper foci remain.

II. In the second form we must cure the circumscribed foci in the mucosa by making local applications of stronger astringents and caustics.

III. In the third form we must act upon the submucosa by pressure and absorbents, in addition to the previously mentioned indications.

In all three cases, however, we must ascertain the localization in order to apply the remedies actually upon all diseased parts.

When to begin treatment is an important question. If we have to deal with a neglected chronic urethritis which has not been treated for a long time, we must begin at once.

Our plan must be entirely different if the patient, up to the time that he came under our care, has been treated for a long time by the various astringents, caustic and instrumental procedures.

In these cases I cannot advise too strongly against the continuance of the treatment. It is urgently necessary to permit a rest in local treatment. We must not forget that prolonged treatment, especially if carried out vigorously and with active remedies, is apt to cause irritation of healthy portions of the urethra, whose secretion aggravates the symptoms. If we wish to know the real condition, the irritative symptoms must be made to disappear by discontinuing the irritation.

I desist, therefore, for several weeks from all local treatment, and, in order that I may appear to be doing something, give internally a little sandal-wood oil, cubebs, or kawa-kawa. If the proper hygienic-dietetic rules have also been carried out, the irritative symptoms, which may have been present, will disappear, and in three or four weeks we have the uncomplicated condition before us.

Finally, it goes without saying that uncomplicated, chronic urethritis alone may be the subject of local treatment.

I. If we proceed according to these principles, and have to deal, as the symptoms prove (I do not recommend the sound and endoscope for the more recent forms of chronic urethritis), with a recent chronic urethritis of the pars anterior, we may inject diluted astringents with the gonorrhœa syringe. It is better, however, to inject under stronger pressure, with the aid of my apparatus. We prescribe:

℞ Argent. nitrat., ... gr. iss.
Aq. destil., ... ℥ iij.

℞ Cupri sulph., ... gr. iss.
Aq. destil., ... ℥ iij.

which is injected once a day in the evening. But the process is rarely confined to the pars anterior. The symptoms or the history of a previous epididymitis or acute posterior urethritis

often indicates with certainty, or at least with great probability, that the catarrhal disease extends to the pars posterior. In such cases the entire urethra must be washed with the astringents. I prefer to do this according to Diday's method rather than with Ultzmann's irrigation catheter, inasmuch as the metallic catheter always irritates more strongly, and I regard the unirritating application of the remedies as very important. With irrigations every second day—every third day if the reaction is marked—the mucous secretion disappears, and the urine contains only flocculi. We now have the second form of chronic urethritis before us. After the urine has cleared up, it is advisable to permit a short interval to elapse before proceeding to the treatment of the localized infiltration in the mucous membrane.

II. If the case is one of the older forms—clap shreds in the clear morning urine—we must localize both the situation as well as the depth of the affection, by the aid of the sound, urethrometer and endoscope.

We will first assume that we are dealing with a superficial chronic urethritis, localized in the mucosa, without beginning stricture or implication of the prostate.

It is then our object to apply the more concentrated astringents upon the site of disease and upon this alone.

If the instrumental examination has shown that the disease is confined to the pars anterior the astringents may be applied most simply by the aid of Ultzmann's brush apparatus. This consists of a narrow hard-rubber endoscope, usually Charrière 16 to 18, whose introduction, with a conductor, into the anterior urethra causes but little irritation. The astringent solution is applied through this endoscope by means of a brush whose handle can be moved in such a way that the hair of the brush alone projects beyond the rim of the endoscope. We may use nitrate of silver 1:30 to 50, or sulphate of copper, which I recommend particularly, in the same strength.

Cases of isolated foci in the pars bulbosa are rare. The process extends more frequently into the membranous portion; often there is also a second focus in the prostatica portion, or the latter alone is demonstrable.

In these cases we may use gelatine suppositories prepared according to the following formula:

℞	Iodoform,	gr. vij.
	Tannin,	gr. iij.
	Zinc. sulph.,	gr. iij.
	Cupri sulph.,	gr. iss.
	Argent. nitrat.,	gr. ¾.

Gelatinæ albæ q. s. f. supposit. urethralia conica No. x. āā 2 inches x ⅛ inch.

These are oiled and introduced by the patient, in the recumbent posture, as far as he is able, with the fingers on the perineum, to follow the urethra. The patient then fixes the bougie by the pressure of the fingers, it melts and thus produces its effect. But this mode of application is uncertain. The liquefied mass sometimes escapes externally, sometimes towards the bladder, and irritates healthy portions of the mucous membrane.

Ultzmann recommends bougies of butter of cacao:

℞	Alumin. crudi,	gr. xv.
	Tannin pulv.,	gr. v.–viij.
	Zinci sulph.,	gr. ij.–v.
	Argent. nitrat.,	gr. iss.

Butyr. cacao q. s. f. supposit. urethralia brevia No. V.

These are inserted into the pars prostatica by the aid of Dittel's "porte remède." (Fig. 24.) This instrument consists of a catheter open at the vesical end, and whose opening is closed by an olive situated on a conducting rod, furnished with a spring. The catheter, closed by the olive tip, is passed into the urethra as far as the pars prostatica, the olive and conducting rod withdrawn, and one of the previously mentioned bougies inserted into the catheter. This is then shoved forwards by means of the olive and deposited in the pars prostatica.

In these cases I prefer to make local injections of a few drops of fluid by means of Guyon's syringe or Ultzmann's catheter syringe.

After the Pravaz syringe of Ultzmann's apparatus is filled a few drops are first deposited in the pars prostatica, and, if necessary, a few drops may also be applied, during withdrawal, to the membranous portion. I use 0.1, 0.5, 1.0, 2.0 per cent. solutions of silver and copper, beginning with the weaker ones and increasing the strength gradually as the irritation pro-

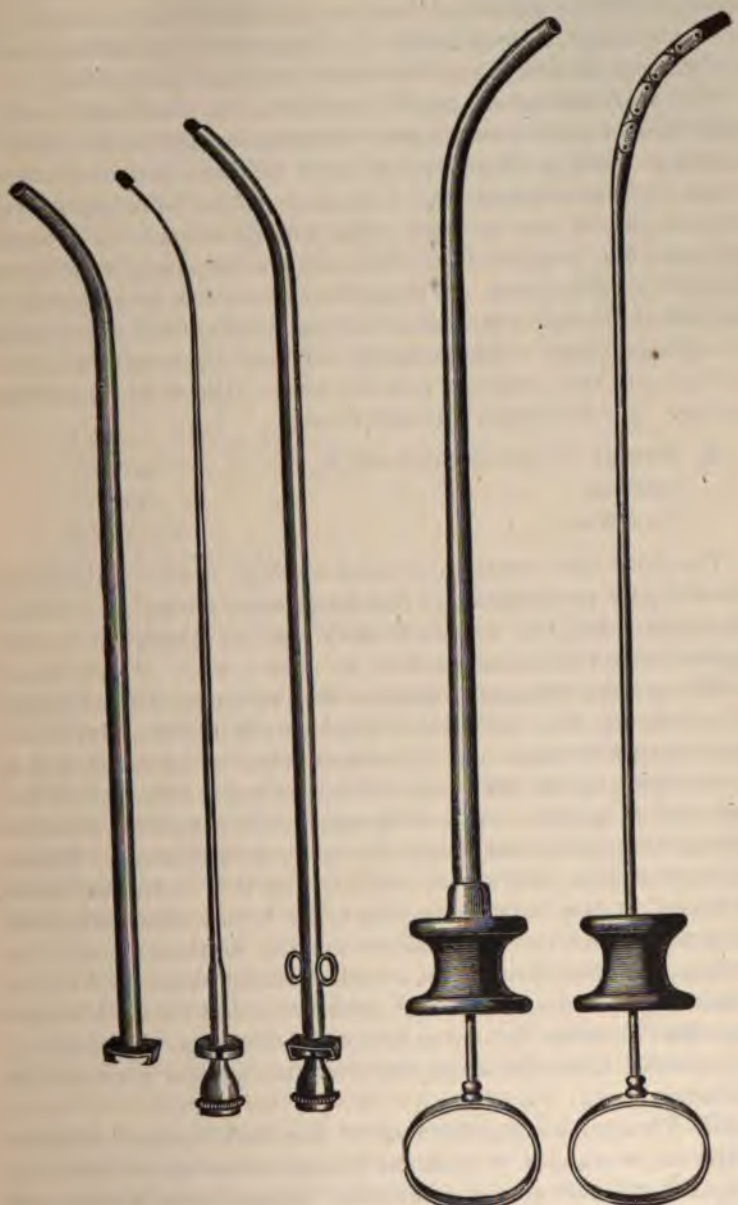

FIG. 24. FIG. 25.

duced by them begins to diminish. The instrument should be lubricated with glycerine, because oil, when carried into the urethra, forms a layer which is permeable with difficulty by the watery solutions, and therefore weakens their action.

The introduction of lanolin ointments is more serviceable than that of watery solutions. Tommasoli (1887) has devised a simple syringe (Fig. 25) for their introduction, and many trials, some associated with him, have led me to recognize the advantages, of this method. The syringe consists of a short catheter, No. 16 to 18 Charrière, with a moderately large opening at the vesical end. Within the catheter is a piston on a somewhat flexible rod, which carries marks, that correspond to a decigramme. The ointment is placed in an ordinary clap syringe and then injected into the open catheter syringe from behind. The following formula is used:

℞	Argent. nitrat. or cupri sulph., . . .	gr. xv.
	Lanolin, ...	℥ iij.
	Ol. olivar., ...	ʒ iss.

The filled and easily lubricated syringe is now introduced into the pars prostatica and one decigramme deposited. During withdrawal, the ointment may also be deposited in the membranous portion and bulb.

The lanolin ointments possess the advantage of adhering intimately to the mucous membrane. If fluids, gelatine or cacao-butter bougies are introduced, they are washed out of the urethra by the first micturition. On the other hand, the contracting urethral walls compress the lanolin ointment after the injection and press it into the mucous membrane. Micturition evacuates only small particles of the ointment, which are found in the urine even thirty-six hours after injection. Even pollutions do not remove all the ointment from the urethra. It therefore forms a real urethral bandage, and its protracted action and gradual absorption have a more favorable effect than the ephemerally acting solutions. In addition, as Professor Liebreich kindly informs me, lanolin is an aseptic substance.

III. Finally, we must consider the last form of chronic urethritis, in which the process extends to the submucous tissues, and produces either stricture or hypertrophy of the caput gallinaginis with secondary prostatorrhœa and neurasthenia.

One of the most sovereign remedies is pressure. We here use sounds of large calibre, beginning with those which barely pass the stricture and gradually increasing to 28 or 30 Charrière, perhaps after preliminary incision of the external orifice. When this form is located in the pars prostatica and the caput gallinaginis is hypertrophied, no stricture can be demonstrated, nevertheless the use of large sounds is often attended with admirable results. In wide strictures the mucous membrane of their surface and surrounding parts is usually the site of chronic inflammation. In addition to sounds we may, accordingly, also use astringents in the previously mentioned manner, applying either aqueous solutions or lanolin ointments to the diseased parts. We particularly recommend the following:

℞	Potass. iodid., ...	ʒ iss.
	Iodin. puri,.	gr. xv.
	Lanolin, ...	℥ iij.
	Ol. oilvar., ...	ʒ iss.
	M. Exactissime.	

This ointment is absorbed well and has often stood me in good stead in old foci in the bulb as well as in the caput gallinaginis. In these cases we first introduce the oiled sound, keep it *in situ* for five to fifteen minutes, and then, by means of Tommasoli's syringe, deposit the above ointment in the pars prostatica, and, if necessary, in the membranous portion.

Winternitz's psychrophor, the cooling sound (Fig. 26), is admirably adapted for cases of isolated disease of the pars posterior with hypertrophy of the caput gallinaginis, prostatorrhœa, and micturition and defecation spermatorrhœa. The instrument consists of a completely closed catheter, of 20 to 24 calibre, which is divided internally into two compartments by a longitudinal septum. These communicate anteriorly at the tip of the catheter and are connected externally, at the fork-shaped end, with two tubes. If one of these tubes is dipped into an elevated vessel of water, and suction made upon the other, the water will run through the catheter (to which it communicates its temperature) and flows into a lower vessel by a syphon action. The catheter is inserted as far as the pars prostatica—its introduction into the bladder may give rise to irritative symptoms—and water is allowed to flow

FIG. 26.

through for about fifteen minutes daily, at first at the temperature of the room, but gradually cooled, in subsequent applications, to 10°C. This may be followed by the injection of a few drops of a strong solution (3 to 5 per cent.) of nitrate of silver, or of a nitrate of silver or iodine-lanolin ointment into the pars prostatica.

If the patient has been examined with the endoscope and tolerates this manipulation well, the results of treatment may be controlled in this way every two to four weeks, and, at the same time, the locus morbi cauterized with sulphate of copper or the solid stick.

The relatively rare polypi, which can only be diagnosed with the endoscope and whose connection with chronic urethritis is questionable, require surgical treatment with forceps, with snares and scissors. The operation may be performed through the endoscope.

And now a few general recommendations concerning all these procedures.

With the exception of Diday's irrigation, which is performed when the bladder is moderately full, all these manipulations should be preceded by evacuation of the bladder.

All local measures are followed by a reaction, greater after injections, slighter after the application of sounds. When the manipulation is confined to the pars anterior the reaction is manifested by suppuration; when the pars posterior is also implicated, by vesical tenesmus.

These symptoms follow the manipulation forthwith, and rapidly reach their acme, after which they soon subside. The reaction is usually ended in six to twelve hours. The tenesmus, which is often distressing after the injection, soon forces the patient to urinate. This is relieved by the preliminary introduction of a morphine or belladonna suppository. It is well to direct the patient not to urinate for several hours after the injection or sounding.

The repetition of the manipulation, application of the sounds, irrigation, or injection, is made every three or four days. It should never be performed earlier than twenty-four hours after the cessation of the reaction occasioned by the previous manipulation. It is also advisable not to treat continuously for too long a time, but to desist for one to two weeks after a period of several weeks' treatment.

The urethra becomes dulled against all irritants and their action becomes more distinct after a rest. In many cases sounding for beginning stricture is no exception to this rule, but we may often carry on the treatment continuously.

The treatment is to be kept up until complete recovery, *i.e.*, until all morbid symptoms have disappeared. But it should not be forgotten that clap shreds consisting of epithelium and desquamations from psoriatic patches are trifling matters and not to be relieved, and that long protracted treatment itself may cause hypersecretion and proliferation of the mucous membrane, *i.e.*, cloudiness of and flocculi in the urine. In other words the effects of the remedies only appear distinctly after the cessation of treatment.

We should always secure regular evacuations from the bowels. Constipation and hemorrhoidal difficulties cause delay in recovery and exacerbations.

Frequent lukewarm sitz baths, full baths and sea-bathing act as adjuvants.

The strict injunctions regarding food and drink which are given in acute urethritis are unnecessary; the patient must simply avoid indigestible, constipating food and an excess of alcoholics.

Moderate exercise is permissible; forced movements, especially riding, are to be eschewed.

The question of coitus is important. When performed with a preventative, infection of the partner is not easily possible.

To forbid coitus in chronic gonorrhœa is impracticable, because the patient will not obey instructions. I therefore consider it advisable not to destroy the patient's candor, but to remain *en rapport* with him on this point. Coitus may be allowed at intervals of three to four weeks, but his attention may be called to the fact that a coincidence of the irritation of treatment with that of coitus will produce a more intense reaction by summation of the irritation, and that an interval of at least forty-eight hours should elapse between local interference and coitus.

It is evident that we must also consider the general nutritive condition, and that any disturbances, which not infrequently react on the blenorrhœa, must be treated. The neurasthenic symptoms associated with chronic posterior urethritis, so long as they remain localized, recover not infrequently as soon as the urethritis is cured. In other cases, especially if they are more diffuse and spinal in character, they require special treatment after recovery of the urethritis.

CHAPTER IV.

COMPLICATIONS OF BLENORRHŒA IN THE MALE.

General Remarks.

In a large number of cases gonorrhœa runs its course in the manner described above. In others, however, the process not alone has a tendency to spread along the surface of the mucous membrane, but also to extend to other tissues or organs.

This extension occurs in two ways. Thus, the process may simply spread deeply, through the mucosa to the submucous tissue and other subjacent tissues, such as the corpus cavernosum.

Or the process extends along the surface. This surface is not continuous, but is interrupted by a large number of excretory ducts of annexed glandular organs. Passing to these mucous membranes which are in direct continuity with the urethra, the inflammatory process extends to the glandular bodies themselves, in which it also sets up inflammation, such as folliculitis, cowperitis, prostatitis, vesiculitis, epididymitis.

The bladder is also affected by direct spread of the disease, which may extend, in rare cases, through the ureters to the pelves of the kidneys and the kidneys.

Finally, there is a third series of complications, which are common to both sexes, but in which the direct way along which the morbid irritation is conveyed is unknown. These will be discussed separately at the close. They include the more remote complications, such as rheumatism, iritis and endocarditis.

The first two groups of complications, which are conveyed directly per continuitatem or per contiguitatem, usually accompany acute inflammation. Some also complicate chronic blenorrhœa, *viz.*, prostatis, vesiculitis, cystitis.

Certain complications, cavernitis, cowperitis, occur in ante-

rior urethritis; others, such as prostatitis, vesiculitis, epididymitis, cystitis, only follow posterior urethritis.

We may therefore distinguish direct complications, resulting from propagation of the process, and remote, metastatic complications. The former are subdivided into those which have developed per continuitatem and per contiguitatem.

Finally, we must distinguish complications of acute and chronic urethritis, and those of anterior and posterior urethritis.

The most important question concerns the mode of origin of these complicating inflammations: Are they also due to the gonococcus? We may state at once that we are entirely in the dark on this subject. It is probable, however, that the gonococcus does not, at least, provoke all of these inflammations.

It is conceivable that the irritation of the papillary body by the gonococcus is so violent in some cases that the ensuing reactive inflammation extends beyond the mucous membrane, and involves the submucous and cavernous tissue. It is therefore conceivable that cavernitis, perhaps many folliculitides, do not develop from the presence of the inflammatory irritant in the cavernous tissue and follicles, but, if I may so express myself, are a remote effect of an intense irritant.

But epididymitis and cowperitis cannot be explained in this way. Here the inflammation does not extend layer by layer from the mucous membrane to the parts in question, but the irritant must have been conveyed to the organs mentioned.

Is this irritant the gonococcus? This is not proven, perhaps not even probable.

The acuteness of the urethral symptoms is directly proportionate to the number of gonococci and the susceptibility of the soil, but this is not true with regard to the occurrence of complications.

In the first place, the most acute urethritides may not be accompanied by complications, and the latter often do not develop after the stage of greatest acuteness. Finally, we know, as a matter of experience, that certain individuals always suffer from complications. Thus, there are patients who never suffer from urethritis without being attacked by epididymitis. This constant occurrence in certain individuals is also known with regard to a remote complication, *viz.*, blenorrhagic rheumatism.

These facts impel us to assume, in many complications at least, a special factor which, favored by the disturbances resulting from the gonococcus, produce further changes of an inflammatory nature.

Lustgarten and Mannaberg demonstrated staphylococcus aureus in the normal urethra, Bockhart found staphylococcus pyogenes aureus in a case of gonorrhœal bubo and periurethral abscess, and in five out of forty-five cases of gonorrhœal pus. Finally, Bumm states that in blenorrhœa of the female, abscesses of Bartholini's glands, periurethral abscesses, cystitis and suppurative parametritis result from inflammation-producers which have penetrated secondarily. It is therefore plausible that the majority, if not all, of the complications of blenorrhœa are produced by specific germs which have entered secondarily, in other words the complications depend on mixed infection.

This assumption becomes more probable when we remember that the majority of these complications do not develop spontaneously, but after external causes, usually local irritation from catheterization, injections, etc., by which the foreign germs are introduced or those previously present are pressed into the mucous membrane. Even in the spontaneous cases it is possible that the blenorrhœic changes produce those conditions, such as exposure of the papillary body and formation of erosions, under which the other inflammation-producers already present produce their effects. These effects are either manifested locally or by entrance into the blood and lymphatics by deposition in remote parts. The question will be considered further under the head of the individual complications. We will here emphasize the importance of aseptic manipulations in urethral blenorrhœa, to which we have already called attention *apropos* of Palliard's case.

I. BALANITIS.

Etiology.

Balanitis is a catarrhal inflammation of the surface of the glans and the inner layer of the prepuce. This is a complication of blenorrhœa in a remote sense alone, inasmuch as it develops at the same time, but does not always depend genetically upon it. The development of balanitis is a double one

in these cases. It not infrequently even precedes the urethritis. The superficial catarrhal inflammation is produced by local irritants of the most varied kinds—for example, by uncleanliness of all kinds, if deposited in the preputial sac and not removed early enough. Now, we notice that not infrequently balanitis develops soon after coitus, usually within twenty-four hours, while the clap does not begin until the fourth or fifth day. In such cases, as a matter of course, the balanitis is not caused by clap, but both have the same source, *viz.*, impure coitus with a blenorrhagic female. But while the clap is due to the specific virus, simple balanitis is the result of the irritant action of the blenorrhagic or otherwise contaminated vaginal secretion.

In other cases the balanitis develops during the course of gonorrhœa. The gonorrhœal pus itself then takes the part of irritant; it flows into the preputial sac, and if not removed with sufficient frequency, gives rise to inflammation. But the *rôle* of the gonorrhœal secretion is then merely an irritating, non-specific one. Balanitis may result from various other causes, such as the irritation of glycosuric decomposing urine in diabetics. The secretion of balanitis contains the most varied forms of cocci and bacteria, also gonococci, if it has been mingled with gonorrhœal pus, but none of these micro-organisms occurs in such proportions that we may claim for it a part in the production of balanitis.

Balanitis has also been looked upon as the consequence of an excessive amount of normal smegma, but this is erroneous. In hospital and dispensary practice we not infrequently see individuals who pay very little attention to the preputial sac, and in which the smegma collects for a long time in such quantities that it finally forms incrustations or preputial calculi. Nevertheless balanitis does not develop in such cases. On the other hand we find scrupulously clean individuals who can detect the beginning of balanitis if they omit cleaning the preputial sac for a single day. If we examine the smegma in such patients, it will be found to be a thin fluid, and it is this which proves especially irritating. Whether this condition of the smegma depends on morbid production or on decomposition immediately after its formation, on account of local influences, we must leave undecided.

When the irritation of blenorrhagic secretion produces

balanitis, a long tight prepuce is a favoring factor, because it interferes with the discharge of the gonorrhœal pus externally and retains it in the preputial sac.

Symptomatology.

The symptoms of balanitis are usually so simple and clear as to admit of no doubt. On examination of the penis externally, we usually find no change, but sometimes the preputial sac appears distended, especially in the region of the corona glandis. In unclean patients we will be struck by the amount of pus which soils the clothes, an amount greater than that produced in acute blenorrhœa in some time. Crusts of dried pus are usually found at the edge of the prepuce. If the prepuce is drawn back and the glans exposed, an abundance of thin, foul-smelling pus escapes, and, after its removal, the inner layer of the prepuce is found to be slightly swollen, reddened, and loosened. The surface of the inner layer is often velvety, even presents small, mulberry-like nodules, is destitute of epithelium, and bleeds easily on contact. These appearances increase from without inwards and are most intense in the coronary sulcus. They are less marked on the glans. In the severest cases the entire surface of the glans is reddened, eroded and secreting. In milder cases we find only superficial eroded patches, or the corona is the site of an extensive erosion, which diminishes towards the glans, the latter presenting only one or a few small erosions. A somewhat annoying itching and pricking in the coronary sulcus, associated at the most with slightly increased sexual excitability, are the sole symptoms of this condition.

In other cases the inflammation is more severe, the entire prepuce is involved and appears slightly œdematous, thus interfering with its retraction. The secretion is more abundant. We then find upon the glans a series of sharply defined, red patches, deprived of epithelium, with jagged, map-like contours. They usually coalesce towards the corona glandis. Pain is generally present in these cases, especially on contact, and is annoying to the patient in walking or on friction of the underclothing against the penis. Erections are accompanied by violent pains, resulting from the stretching of the prepuce by the erect glans.

If the inflammatory symptoms progress the œdema of the prepuce also increases. The entire penis then assumes the shape of a club, which is larger towards the glans. In these cases reposition of the prepuce is no longer possible (phimosis). If the inflammatory swelling and œdema increase still more, the mutual pressure of the glans and prepuce may give rise to circulatory disturbances, or even partial cessation of circulation, which then results in gangrene. As the gangrene is always moist, an ichorous, instead of a purulent, secretion takes place from the preputial sac. The prepuce then has a dark red, livid red or even blue color, and if it is incised, as is absolutely indicated in such cases, the inner layer of the prepuce, more rarely a portion of the corona glandis, is found converted into a putrid, spongy, ichorous mass. If left to itself the gangrene of the inner layer usually penetrates, at some point, through the entire prepuce, especially on the dorsum. An opening is thus formed in the prepuce, through which the glans forces its way. This relieves the circulatory disturbance, the gangrenous portions are exfoliated, and recovery occurs by means of granulations and cicatrization. The rest of the prepuce shrivels, and hangs from the bare glans as an apron-like appendix. The general condition usually suffers, fever and even indications of stupor set in, but, on the other hand, there may be complete apyrexia without constitutional symptoms.

In the milder cases—with moderate œdema and without gangrene—complete absorption usually follows. But in some the absorption is incomplete, and slight thickening of the integument of the prepuce remains. If these attacks of balanitis with œdema recur, and the absorption remains incomplete, rigidity and thickening of the prepuce finally result, and its reposition is interfered with or made impossible. Such a rigid, elephantiatic prepuce is apt to be fissured during coitus, especially at the margin, and thus predisposes to infection. The fissures, which are easily inflamed, soiled by urine, and heal with difficulty, give rise, if frequently repeated, to constantly increasing sclerosis and narrowing of the opening.

If erosions on the glans and inner layer of the prepuce are in apposition during a balanitis, and remain in contact for a long time on account of phimosis, they may finally result in partial adhesions. Even complete adhesions may form over a larger or smaller surface, starting from the coronary sulcus and ex-

tending over the corona to the middle of the glans, etc. The line at which the adhesion ceases, becoming eroded by a fresh balanitis, gives rise to extension of the adhesion, which may advance finally to the orifice of the urethra.

As a matter of course, balanitis cannot develop when the preputial sac is absent, as in circumcised individuals. But ritual circumcisions are often performed roughly with the aid of sharp finger nails, instead of the knife, and the glans is thus injured. The remains of the prepuce may then adhere to these injured spots, and span the coronary sulcus like a bridge. In the cavities which are formed in this way a catarrhal inflammation, which is entirely analogous to balanitis, may develop, and if neglected, may give rise to swelling of the bridge-shaped remains of the prepuce, to pain and often to quite violent inflammatory symptoms.

Diagnosis and Differential Diagnosis.

The diagnosis is evident from the above-mentioned symptoms, and we might imagine that there can be no doubt in cases in which retraction of the prepuce is possible. Nevertheless, mistakes are often made in such cases, and urethritis and balanitis are often confounded. In cases of abundant purulent secretion from the urethra, when the prepuce is long and narrow, the secretion will flow into the preputial sac. If the prepuce is now retracted and the glans laid bare, exposing at the same time the inner layer, both appear to be covered with pus, which really comes from the urethra. This appearance leads careless observers to make the diagnosis of balanitis. In order to avoid mistakes it must be remembered that in balanitis the surface of the glans and inner layer of prepuce is not alone covered with pus, but also reddened, swollen and inflamed. If the pus is removed and the underlying tissue found pale and normal, balanitis is excluded.

But if these parts are found red and swollen it must also be remembered that an urethritis may also be present, in addition to the balanitis. In order to convince ourselves the pus is wiped out of the preputial sac or washed away with the irrigator, after the patient has not urinated for several hours. Pressure is now made on the orifice of the urethra. If this forces pus from the urethra which contains gonococci

under the microscope, the diagnosis is clear. If pus does not appear at the meatus, the patient is directed to urinate in two portions, and the cloudiness of one or both portions reveals the diagnosis and localization of the urethritis.

If phimosis is present, the pus escapes from the orifice of the prepuce. There are then two possibilities. 1. Blenorrhœa may be combined with the phimosis, or, 2, the balanitis is the cause of the phimosis. We must then ascertain whether the suppuration comes from the preputial sac or from the urethra. In order to answer this question the patient is directed to hold his urine for several hours, and then the pus is washed out of the preputial sac by means of an irrigator and narrow drainage tube, which is carried into the sac, or by a syringe with a long narrow tip, which may be inserted between the glans and prepuce. The patient then micturates. If the urine is clear, the pus comes from the preputial sac, while a purulent cloudiness of the urine can only come from the urethra.

But it must not be forgotten that when the suppuration is present in the preputial sac alone, *i.e.*, when blenorrhœa is excluded, the balanitis may owe its origin to a soft chancre, to syphilis in all its stages, or to carcinoma. The pus of soft chancre is inoculable. It would, therefore, only be necessary to inoculate the patient by the aid of a lancet, with the pus obtained from the prepuce. But this procedure is usually superfluous, and is to be decidedly discountenanced in private practice. Nature often performs this inoculation for us. The pus flows upon the scrotum, thighs, margin of the prepuce, macerates these parts and produces eczema. These eroded and macerated places are infected by the pus, and we usually find, in such cases, soft chancres on the margin of the prepuce, scrotum and thighs. On the other hand, the phimosis offers favorable conditions for absorption of pus on account of its retention, and thus for the development of adenitides. Hence, soft chancres, which are complicated by phimosis, are usually followed by acute adenitis.

If the phimosis results from a syphilitic sore, its rigidity is usually felt from the outside. An indolent, nodular lymphangioitis, multiple indolent glandular swellings, and recent secondary symptoms, confirm the diagnosis.

If the phimosis is the result of secondary papules—a rare event—the case is cleared up by other older symptoms of

syphilis, papules on the buccal mucous membrane and around the anus, palmar and plantar psoriasis, pustules on the head, eruptions on the trunk.

The diagnosis of phimosis due to gummata follows the demonstration of old syphilis, residua of the secondary period, old and recent tertiary symptoms. The diagnosis is further fortified by the long existence of a firm nodule, which is felt through the external coverings, by the absence of glandular enlargements and recent secondary symptoms, and finally by the results of treatment.

When carcinoma is the cause of the phimosis we find considerable long-standing, usually ichorous destruction of tissue; absence of inflammatory symptoms; the characteristic, multiple, metastatic glandular enlargements, as hard as bone, and a cachectic condition.

Finally, acute development, slight increase in the size of the glans and absence of complications favor the diagnosis of balanitis alone as the cause of the phimosis.

Treatment.

In simple balanitis, uncomplicated with phimosis, whether with or without blenorrhœa, the treatment is quite simple. Cleansing and evacuation of the pus several times a day, drying and isolation of the inflamed surfaces, are the indications. The patient bathes the penis, with the prepuce retracted, two or three times a day in not too cold water, to which carbolic acid or chloride of zinc (1 per cent.) has been added, then removes the pus with cotton and dries the parts. The glans is then covered with a thin layer of pure dry cotton, over which the prepuce is drawn. Or a bland powder, such as rice powder or talcum venetum, is strewn thickly on the glans and coronary sulcus, and the prepuce drawn over it. Erosions are cauterized with solid nitrate of silver, or the entire preputial sac is brushed with a 50 per cent. solution. The patient may also use nitrate of silver (gr. vij. : ℥ v.) for irrigation. Resorcin (5 to 10 per cent. solution) as a bath or brushed upon the preputial sac also gives good results. Tannin, used as a dusting powder, effects rapid recovery. This may also be applied for a long time to harden a delicate, tender glans and internal lamella, and thus prevent balanitis.

If phimosis is present, the chief indication is the evacuation of the secretion. Recovery is usually effected rapidly by injections of a weak solution (gr. vij. : ℥ v.) of nitrate of silver or resorcin (5 to 10 per cent.). Zeissl recommends rapid cauterization by passing the solid stick between the glans and internal lamella.

More violent inflammatory symptoms are combated by rest, elevation of the penis, moderate antiphlogosis; œdema is relieved by scarifications. If the œdema is pronounced, and gangrene is threatening or beginning, we must avoid vigorous antiphlogosis, inasmuch as this favors the spread of the gangrene by interfering still more with the circulation.

If the phimosis cannot be relieved by antiphlogistics, and gangrene is impending or has already developed, a dorsal incision must be made or circumcision performed.

Balanitis in the bridged portions of the coronary sulcus heals on dividing the bridges with a bistoury or pair of scissors.

When balanitis and phimosis are present, a coincident urethral gonorrhœa cannot be treated locally until the former have subsided.

II. FOLLICULAR AND CAVERNOUS INFILTRATION AND ABSCESSES.

SYMPTOMATOLOGY.

Although the blenorrhagic process is confined chiefly to the surface of the mucous membrane, there is hardly a case of acute urethritis in which at least some of the numerous follicles and glands in the mucous membrane are not implicated in the inflammatory process. We have already called attention to the fact that palpation of the pendulous portion during acute inflammation often reveals a series of larger or smaller nodules (sometimes as large as a hemp seed) which cannot be found in the normal urethra. These nodules—the larger ones are somewhat painful—are enlarged follicles. In many cases the inflammation is confined to the follicles, or spreads at most to the innermost layers of the peri-follicular connective tissue, and then constitutes a relatively slight affection. This can be followed most accurately at the orifice of the urethra. Both labia contain rather large follicles, which take part not infrequently in the blenorrhagic process. We then notice some-

what more marked swelling and redness of the labia, and if the latter are separated, cleansed of pus and pressure exerted upon them, pus will escape on both sides from one or two narrow openings. These openings, which admit fine probes, lead into canals ½ to 1 ctr. long. This affection is especially frequent in connection with slight hypospadias, when the glands and their openings are usually larger.

The inflammation of the glands and follicles may become more intense and diffuse, the perifollicular tissue assuming a more prominent part. This is owing to the increased inflammation from occlusion of the excretory ducts, by inflammatory swelling or firmly adherent plugs of mucus and pus—a condition that is apt to develop in view of the long, oblique course of the ducts through the mucous membrane. Or the inflammation may be intensified by external mechanical, traumatic and chemical irritants.

At the frenulum the environs of these follicles are formed exclusively of connective tissue, which here occupies the entire breadth of the frenulum and fills up the space left by the corpus cavernosum glandis. At the frenulum, likewise, there are a large number of these follicles and glands, which empty into the fossa navicularis, and inflammation is frequent here. We then find on one or both sides of the frenulum, in the niche formed by it with the coronary sulcus, a moderately firm, nodular swelling, covered by reddened skin, which is painful on pressure and may attain the size of a pea; this soon softens, perforates and discharges a little pus. Examination with the probe shows a small cavity which does not usually communicate with the urethra. Rupture into the urethra is rare. If two symmetrical infiltrations form to the right and left of the frenulum at the same time, they often become confluent, push forward the frenulum, which presses upon the middle of the single nodule by a cicatrix and divides it into two halves. The suppuration in the nodule not infrequently coalesces before it ruptures externally, and, when this has happened, the probe discloses a cavity beneath the frenulum, opening on either side, and thus undermining the frenulum. Œdema of the glans and prepuce, pain on contact, erection and micturition, are the further symptoms of this still mild affection, which presents the disadvantage, however, of being apt to return on renewed infection.

In all other parts, with the exception of the fossa navicularis, the glands and follicles are imbedded either in part or entirely in the cavernous tissue. If the inflammation extends beyond the boundaries of the follicular and perifollicular connective tissue, it must pass into the cavernous tissue. So-called cavernous infiltrations then develop from the perifollicular inflammation. Starting from a small, painless, follicular infiltration there develops, usually rapidly and attended with quite violent pains, a nodule which may grow to the size of a pea or hazel nut. It is situated in the corpus cavernosum urethræ, from which it projects like a nodule, and in the beginning is covered by the movable integument of the penis. Violent pains, spontaneous and on contact, exacerbation of the pains during erection, slight febrile movement, are the attendant symptoms. In some cases of marked swelling the stream of urine is materially narrowed. Resolution may set in if the inflammation of the gland resulted from closure of the excretory duct and the plug becomes loosened. But the closure of the duct usually results from swelling of the mucous membrane over the nodule. Softening of the nodule commonly occurs under such circumstances. The skin of the penis becomes reddened over the nodule and applied to it. In the meantime the internal wall, formed of the more delicate mucous membrane, may have yielded, the abscess discharges into the urethra, and a small flow of bloody pus escapes from the meatus. If urine enters the open abscess cavity at the next micturition, urinary infiltration and extensive cavernitis may result.

In other cases rupture occurs externally and internally at the same time. During micturition the urine passes through the internal opening into the abscess cavity and then out through the external opening. This diminishes the danger of urinary infiltration, but opens the way for a urinary fistula, inasmuch as the urine which escapes through the abscess cavity prevents complete healing. The most rare and favorable termination is that in which the abscess ruptures externally alone and then usually heals rapidly.

These circumscribed infiltrations may develop in all parts of the pars cavernosa. The favorite site is the bulb, in the first place because this is very rich in glands and follicles, then because stagnation of pus at the bulb and external injuries are apt to cause intensification of the inflammation. The swelling,

which is very painful and more extensive than in other parts, is not round but is sharply defined, round posteriorly, terminating in a point anteriorly; when very large, it always interferes with micturition, is accompanied by fever, and rapidly softens. Rupture internally furnishes very favorable conditions for urinary infiltration, especially as the bulb is so well adapted for the stagnation of the urine left in the urethra.

More extensive inflammations of the corpus cavernosum may also set in. These develop as the result of acute urethritis in various ways. They start from a folliculitis which has ruptured internally, from rupture of the urethral mucous membrane during vigorous erections, coitus, "breaking a chordee," or violent irritation affecting the inflamed mucous membrane.

If the process was preceded by folliculitis with rupture internally, the patient suffered first from the symptoms of the former affection, which rapidly improved after discharge of pus through the urethra attended by diminished size of the nodule. One or two days after the rupture, however, the former nodules increase rapidly in size and become very painful, and the previously circumscribed swelling extends over a large part of or the entire corpus cavernosum penis. The integument over the swelling is reddened, urination obstructed, the stream small and feeble, and micturition is attended with violent pain in the infiltration. The boundaries of the latter usually cannot be felt very distinctly. On account of this swelling the corpus cavernosum urethræ is fuller, as if semi-erect, so that the penis is curved, with the concavity towards the abdomen. If an erection occurs the corpus cavernosum urethræ, whose meshes are swollen and its cavities narrowed on account of the inflammation, cannot accommodate as much blood as the normal corpora cavernosa penis. It therefore becomes less erect and a curvature of the penis results, with the concavity downwards. This chordee is naturally attended with violent pain. If the cavernitis is due to urinary infiltration, purulent degeneration occurs with rupture externally, unless a more grave sequel sets in, *viz.*, ichorous, gangrenous destruction attended with severe febrile symptoms, which may prove fatal from pyæmia. If it is due simply to increase of the inflammatory phenomena, dependent on local irritation, the inflammation may terminate in resolu-

tion. It may also end in induration, conversion into fibrous connective tissue, which then causes permanent disturbances of erection, chordee and impotentia coeundi from obliteration of a portion of the corpus cavernosum. In a case of this kind A. Guerin (1854) found, on autopsy, that the spongy tissue had disappeared completely, and that the bundles which form the alveoli were thickened and inelastic. Tarnowsky describes a case of extensive acute inflammation involving all the erectile bodies. The patient had made an injection, by mistake, of a concentrated solution of nitrate of silver. Fifteen hours later Tarnowsky found him in bed, the penis completely erect, the skin reddened and hot, the slightest movement, even a current of air, produced the most violent pains. Bloody pus escaped from the urethra. Urination was impossible on account of the agonizing pains produced by the passage of urine through the canal. Even when at rest the pain was felt not alone in the entire penis, but also extended to the perineum, and was increased to the utmost by adduction of the thighs, so that the patient was forced to assume a semi-recumbent position with the thighs adducted and flexed at the knees. Leeches to the perineum, ice compresses, and inunctions of gray ointment resulted in resolution, but three months later an elongated induration, as large as a hazel nut, could still be felt at the middle of one of the lateral walls of the penis.

Chronic gonorrhœa is followed by complications of this kind much more rarely than the acute form. As the result of exacerbations the process sometimes spreads to one or the other follicle or gland, but the course of this folliculitis is subacute, and usually terminates in induration. On palpating the urethra of a man suffering from chronic gonorrhœa we then find one or more painless, firm nodules, perhaps as large as a hemp seed, in the course of the corpus cavernosum urethræ.

Stricture is a not infrequent cause of peri-urethral cavernous infiltrations in old chronic urethritis. Ulceration with urinary infiltration is a not uncommon retro-strictural change, and may give rise to cavernous infiltration. Inasmuch as the bulb is the favorite site of stricture, these changes are usually located immediately behind it in the pars membranacea, but may also appear in other places.

Kreiner reports a remarkably severe case of this kind, in

which there is doubt as to the origin from acute or chronic urethritis, because the patient did not come under observation until the changes were completed. In a waiter, æt. twenty-one years, who had entirely neglected a urethritis for three years, the following condition was observed: the penis is of moderate size as if semi-erect, curved slightly to one side, the glans disproportionately thick, of a bluish livid color, with numerous openings resembling the prick of a needle. The posterior segment of the frenulum præputii is very thick, and two rather large openings are found on either side. On palpation the urethra and its corpus cavernosum, from the middle of the pendulous portion to the external orifice, is found to be very thick and hard, as if it contained an elastic catheter of large calibre. Here and there an induration as large as a pea. The glans penis feels like a large callosity, the meatus is retracted by cicatricial tissue and very narrow, so that only a fine bougie is introduced with difficulty; it is almost entirely covered by proliferating granulations which start from its ulcerated border. If the urethra is squeezed moderately from behind forwards, creamy pus appears not alone at the meatus but also at the previously mentioned openings in the glans, as if from a sieve. The patient micturates with difficulty, using the abdominal muscles, and the stream is very small and spiral; the urine trickles from the openings in the glans and spirts in two very fine streams from the openings alongside the frenulum. This also occurs if fluid is injected into the urethra by means of Sigmund's syringe.

Finally, we must mention another change, *viz.*, chronic induration of the corpora cavernosa, which does not follow florid blenorrhœas, whether acute or chronic, but develops in an insidious manner after such processes have run their course. This condition is mentioned by Tarnowsky, Van Buren and Keyes and Mauriac.

This consists of a painless, chronic thickening of the corpora cavernosa. The patient first experiences some pain during erection, and on palpation finds a firm nodule in one of the corpora cavernosa. This can also be felt when the penis is flaccid. It slowly enlarges. When it becomes almost as wide as the corpus cavernosum it causes disturbance during erection, but remains firm and painless. If the size increases still more, the penis becomes bent during erection. In some cases

the induration has a flat shape, is firm and elastic but stretches very little, so that it hinders erection; it never extends through the entire thickness of the corpus cavernosum. Several nodules sometimes develop in one or both corpora cavernosa.

The diagnosis of these forms is evident from the symptomatology. Acute forms, without coincident blenorrhœa, are not observed unless there have been local injuries of a traumatic nature. The inflammatory symptoms, the infiltration felt on palpation, the demonstration of blenorrhœa, enable us to make the diagnosis without difficulty. In chronic induration syphilis must be taken into consideration. The previous history and the demonstration of luetic symptoms furnish the basis for treatment, which is also effective in the blenorrhagic affection.

The prognosis should never be made unqualifiedly favorable. Even the mildest forms of follicular abscesses may give rise to urinary infiltration. This condition always impairs the prognosis materially, on account of the danger to the potentia coeundi from extensive destruction of the corpus cavernosum, the possibility of a permanent urinary fistula, finally, of pyæmic symptoms. Chronic induration, which is with difficulty amenable to treatment, cannot endanger life, but threatens the potentia coeundi.

Treatment.

The first indication is complete rest, of the body as well as of the genitalia. If possible the patient should be kept in bed, sexual excitement combated in the well-known ways, the food should be bland, and easy evacuations should be secured. All local treatment of the gonorrhœa, whether external or internal, should be discontinued at once.

In recent infiltrations, which show no softening or fluctuation, vigorous antiphlogistic measures must be adopted at once. Cold compresses are first applied assiduously. When the pain has disappeared, absorption is aided by inunctions of gray ointment. If fluctuation or softening is noticed, immediate incision will prevent rupture internally. If rupture internally has occurred, communication is established by incision of the abscess externally, and the case treated according to surgical principles. Threatening urinary infiltration and fis-

tula are avoided by the introduction of an elastic catheter à demeure. This should also be done, and an external incision made, even after urinary infiltration has occurred.

If a fistula remains after recovery, it must be treated surgically. Indurations, whether chronic or the residua of acute inflammation, are treated with vapor compresses and application of iodine. Until the infiltrations have entirely disappeared, erections and coitus must be prevented, because they may be followed by very serious consequences as the result of rupture and hemorrhage.

Folliculitides of the urethral meatus are treated by the passage of a narrow stick of lunar caustic or hot needles into the gland. If hypospadias is also present, the excretory duct of the gland may be divided.

In undermining of the frenulum by abscesses complete division of the remaining bridges is indicated.

III. INFLAMMATION OF COWPER'S GLANDS.

General Remarks.

Although Cowper's glands had been described by Théry in 1684, and Cowper described them anew in 1702, their pathology long remained obscure. Cowper attributed the discharge of vitreous, tough fluid at the end of an urethritis to disease of these glands, and also reported a case of ulceration of the excretory duct. Littré (1711) also brought chronic urethritides in connection with disease of Cowper's glands, and described a case of swelling of the gland with ulceration of the excretory duct. In an autopsy on a young man Morgagni found narrowing of the excretory duct as the result of a cicatrix. Hunter mentioned Cowperitis cursorily, and recommends vigorous treatment with mercury. B. Bell regarded it as a dangerous complication of urethritis, which gives rise, in some cases, to an incurable urethral discharge. Swediaur mentioned retention of urine from enlargement of the gland. Gabler (1849) was the first to give a detailed account of the diseases of Cowper's glands in a thesis prepared under Ricord's supervision. In 1849 Linhart presented to the Vienna Medical Society two preparations, one of suppuration of Cowper's gland with gangrene of the mucous membrane of the

urethra, the other of suppuration of the middle lobe of the gland. Other cases have been reported by Bartels, Nicolle, Ravogli and Rasori, and Bowie, but the affection is rare and relatively little studied.

SYMPTOMATOLOGY.

Acute Cowperitis is always a complication of acute gonorrhœa. At the end of the second week after infection the inflammation reaches the bulb into which the excretory ducts of Cowper's glands empty, so that Cowperitis cannot develop before this period. Fournier states that the third and fourth weeks of acute urethritis are the favorite period for the occurrence of this complication.

In some cases the spread of the inflammation is provoked by injuries which increase the intensity of the blenorrhœa, such as traumata, excessive movement, riding, dancing, coitus, strong injections or introduction of bougies. In other cases no exciting causes are found, the inflammation appears to develop spontaneously. In Tarnowsky's case an acute Cowperitis developed in a chronic urethritis of two years standing, as the result of prolonged riding.

The symptoms and course of the disease are usually simple. At first the patient generally feels a sticking pain in the perineum, which leads him to make an examination. On palpation, which is always accompanied by pain, a sharply defined nodule is felt a little behind the bulb, *i.e.*, about half way between the posterior edge of the scrotum and the anus, and to the side of the median line. This is about as large as a hazel nut at the beginning, grows more or less rapidly, is sharply defined and covered by movable integument. The blenorrhagic secretion from the urethra diminishes or ceases entirely. Micturition is undisturbed, defecation is attended with pain in the perineum. The clinical history is not infrequently confined to these symptoms, which diminish, and the disease is then cured or the inflammatory symptoms disappear, while the nodule remains and becomes indurated.

In other cases, however, the inflammation progresses, the nodule becomes as large as a nut or even larger, and the skin is pushed forward. It usually loses its sharp boundary and becomes elongated, the anterior smaller extremity reaching to

the bulb, or it extends along the corpus cavernosum while the posterior blunt extremity ends at the transverse perineal fascia. The inner border may reach the median line or even pass beyond it, but the tumor is always asymmetrical on account of its predominantly lateral development. The swelling then has a doughy feel and is covered by inflamed, reddened skin. Compression of the urethra in these cases interferes with micturition, the stream is narrow, the symptoms like those of stricture.

Fever, chills and throbbing pains in the tumor are signs of beginning suppuration, which usually perforates externally in a few days, and often discharges astonishing amounts of pus. The pain and disturbances of micturition then cease, and the urethral discharge, if it has been in abeyance, returns. The abscess cavity fills with granulations and usually heals rapidly. The retraction of the recently formed cicatricial tissues may cause compression and distortion of the urethra and thus narrowing of its lumen, as in Bartel's case.

Perforation internally is more rare, and still rarer is perforation in both directions at the same time. Much then depends upon the course followed by the urine. Even despite perforation internally the urine does not enter the abscess cavity in many cases, and recovery rapidly follows. In such cases the perforation may be situated in such a position that the stream of urine, which distends the urethra, closes the opening. The urine may also not escape when the perforation has taken place internally and externally. In other cases the urine enters the abscess cavity and then passes through the perineum, if external rupture takes place. Urinary infiltration and fistula are the result.

But Cowperitis does not always run such an acute course in all cases. Tuffier reports the case of a patient, æt. sixty years, who died of emphysema. He had suffered from blenorrhœa and dysuria, which were found, during life, to be due to stricture of the urethra. The autopsy showed that the stricture resulted from an abscess of Cowper's gland which projected into the urethra. In Hamonic's case a man of twenty-two years, of a tuberculous family, who presented the symptoms of bronchitis at the apex, acquired an urethritis. In the third week a painless tumor developed in the perineum. Five weeks after infection it was as large as a walnut, pain-

less, doughy, covered with pale skin, and fluctuating. The tuber ischii was tender on pressure and appeared to be connected with the tumor by a band. Hamonic made a diagnosis of cold abscess from disease of the os ischii. An incision discharged pale yellow pus, but no rough bone could be felt. The abscess cavity was lined by a thick pyogenic membrane. Extirpation and anatomical examination showed inflammation of Cowper's gland. Tuberculosis was excluded histologically and bacteriologically.

Bilateral Cowperitis is rarer than the unilateral form. The symptoms are the same, but the swelling is bilateral or symmetrical from confluence. The pressure on the urethra and the subjective symptoms are more marked. Perforation externally is usually later on one side than on the other, and this leads not infrequently to communication of both abscesses and thus to exposure of the posterior periphery of the bulb; this may result in serious fibrous compression when the abscess heals. In these cases the infiltration in the perineum generally extends to the anal opening and upward along the latter, but is always separated from the prostate by a groove.

According to Ricordi and Jullien, chronic Cowperitis runs a different course, being manifested only by a morbid secretion without subjective symptoms. In some cases this secretion is opaline and occasionally becomes purulent, and cannot be distinguished from that of chronic urethritis. In other cases the discharge, which passes the meatus in the morning, is a gelatinous, stringy mass, which is found under the microscope to contain the epithelium of Cowper's glands.

In the absence of *post-mortem* examinations and the striking similarity of the symptoms with those of chronic urethritis, the question of the existence of chronic Cowperitis must remain an open one. I have never observed such cases.

Diagnosis and Differential Diagnosis.

This is evident from the symptoms, but it is especially the inflammation limited to the gland which cannot easily be mistaken. In advanced cases the diagnosis becomes more difficult. It is then possible to mistake it for simple cutaneous abscess of the perineum, cavernous infiltrations and abscesses of the bulb. The cutaneous abscesses, however large they

may be, are not apt to cause compression of the bulb. Abscesses of the bulb are distinguished by their median, more anterior position, from the asymmetrical, more posterior Cowperitides. Urinary infiltrations resulting from stricture are recognized by the fact that they follow chronic urethritis, have long been preceded by symptoms of narrowing, and that the narrowing does not disappear after perforation or incision.

Prognosis.

This is favorable when the disease is confined to the gland, but a guarded prognosis should always be given when the inflammation extends to the peri-glandular tissue, inasmuch as urinary infiltration, fistula, and fibrous compression of the urethra may give rise to disagreeable or even dangerous symptoms.

Treatment.

This consists simply of the cessation of all local treatment of the urethritis, rest, and cold compresses and ice-bags to the perineum in the acute stage, if no fluctuation is felt. If fluctuation is present it must be treated surgically by immediate incision. Induration of the gland or peri-glandular tissue disappears on inunction of gray ointment or application of vapor compresses.

IV. INFLAMMATION OF THE PROSTATE.

General Remarks.

That the prostate may take an active part in the blenorrhagic process is an old experience. Indeed the part played by this organ was often exaggerated in former times. Thus, Zeller, Littre and Warren regarded clap as an inflammation and suppuration of the prostate. This view was owing to the fact that an autopsy is rarely held on simple, uncomplicated gonorrhœa and only as the result of intercurrent affections, while urethritis only terminates fatally when aggravated by severe complications, among the most prominent of which is prostatitis.

The prostate also played a large part in the pathology of clap even after clearer views of the nature of the disease were entertained. Thus, Swediaur and Girtanner (1803) located chronic blenorrhœa in the prostate, claiming that the latter was more or less affected in almost every case. The prostate sometimes remained swollen, large and hard, even after complete recovery from the clap. The hardness and enlargement increase until finally the prostate occludes the neck of the bladder. Wendt (1827) thought that the prostate is more or less implicated in every violent gonorrhœa, and Vidal (1854) believed that clap plays its part in the etiology of prostatic hypertrophy of old age.

Accurate investigations have shown that the prostate may be affected as the result of acute as well as of chronic gonorrhœa. We must therefore distinguish acute as well as chronic diseases of the prostate, which generally follow the corresponding forms of urethritis. The spread of the process is due to various causes, but they always consist of irritants which gives rise to exacerbations of the urethritis, such as excesses in Baccho et Venere, immoderate exercise, local irritation (strong injections, catheterization, etc.). Certain prostatitides develop spontaneously or at least without any ascertainable cause. The ready passage of the inflammation from the mucous membrane to the prostate is explained by their intimate anatomical connection.

SYMPTOMATOLOGY.

Acute Prostatitis.—Implication of the prostate in acute urethritis from direct continuation of the inflammation from the mucous membrane can only occur, as a matter of course, when the pars prostatica is the site of the blenorrhagic process. Hence posterior urethritis alone is followed by prostatitis, and the latter will not appear until the third week after infection. An exception obtains in those cases in which pus is carried into the pars posterior at the beginning of an acute urethritis by instrumental examination.

According as the extension of the blenorrhagic process to the pars posterior occurs acutely (on account of external injuries) or spontaneously and slowly, it will be accompanied by the well-known symptoms or run a latent course.

The development of prostatitis is therefore either preceded by the symptoms of acute posterior urethritis or the latter are absent.

Or the extension of the process to the pars posterior may be almost or entirely coincident with the acute prostatitis, so that the symptoms of both will occur together.

I cannot state in figures the frequency with which acute posterior urethritis is complicated by prostatitis, but it is undoubtedly very frequent. Sigmund (1858) believed that every clap which had lasted several weeks was followed by swelling of the prostate, which is often very considerable, and which may not disappear even after recovery from the clap. Montagnon and Erand state that the prostate is attacked in 70 per cent. of the cases of posterior urethritis.

The prostate may take part in acute posterior urethritis in four different ways.

Congestion of the Prostate.—This is the most frequent form. The posterior urethritis has begun either in the well-known way or has developed in an entirely latent manner, when the patient complains of a feeling of pressure and weight in the perineum and fullness in the rectum. Vesical tenesmus is somewhat increased, and defecation is apt to be painful, especially if the fæcal masses are firm. On examination per rectum the prostate is found enlarged, either uniformly or irregularly, feels warmer, and is painful on pressure. The urethral secretion does not diminish, the test of the two beakers shows cloudiness of both. This condition lasts so long as the acute stage of the blenorrhœa continues and disappears spontaneously in a few days. External irritants at this time, particularly injections and coitus, may increase the congestion and give rise to inflammation. Frequent pollutions, resulting from the increased sexual excitability induced by disease of the pars prostatica, may have the same effect. But we must be on our guard against declaring every tenderness of the prostate on pressure through the rectum as congestion, because this may be simulated by the mere tenderness of the pars prostatica.

Acute Folliculitis.—Usually during the stage of acute posterior urethritis, or when exacerbation of an inflammation of the pars posterior, which has run its course, results from external injuries (injections, coitus, onanism), the patient ex-

periences an increasing vesical tenesmus, generally within six to twenty-four hours after the action of the exciting cause. As a rule the tenesmus lasts only a few hours, at the most a day, and compels the patient to urinate every half hour or even more frequently. The increased secretion of pus, which would otherwise have followed the exciting cause, remains absent, but both portions of urine are cloudy. The cloudiness is mucus, and is deposited after a long time in the shape of small flakes. The addition of acetic acid sometimes causes partial clearing up, an evidence that phosphaturia is also present. The contraction of the neck of the bladder on the passage of the last drops of urine, and the elevation of the perineum by its muscles, are attended by a burning or shooting pain which the patient often locates accurately in the same point. Micturition is also attended with a burning pain in a fixed point of the deepest portion of the urethra. On rectal examination the prostate hardly appears to be enlarged, but one or two firm nodules as large as a pea, which are sharply defined from the remaining soft parenchyma, can be felt, usually only in one lobe. Pressure on these nodules causes shooting pains. If no further morbific influences are at work the subjective symptoms disappear rapidly, the nodules are absorbed, and the original condition returns or an exacerbation of the urethritis sets in.

Parenchymatous Prostatitis.—This may develop directly or from either of the previously mentioned forms. It usually begins with increased tenesmus, a feeling of fullness in the rectum and pressure on the perineum. The secretion disappears, fever sets in and all the symptoms are aggravated. Micturition is obstructed by the swelling of the prostate, and a small stream is discharged, with violent contraction of the abdominal muscles. Defecation is very painful from pressure on the swollen gland. At the same time there are spontaneous, violent, shooting or boring pains in the perineum, which radiate towards and along the urethra, and also towards the rectum, small of the back, and thighs. Some patients describe a sensation of a painful "nut" in the rectum. Rectal tenesmus is also distressing. Pressure on the perineum is painful, so that the patients are usually unable to sit, but assume a recumbent position with flexed thighs. Rectal examination in these cases often shows very considerable swelling of the

prostate, which is tender on pressure, warm to the feel and projects far into the rectum. The symptoms increase in severity for five to six days. The enlargement of the gland may cause complete retention of urine and fæces which, associated with the constant vesical and rectal tenesmus, entails the greatest distress. Towards the end of the first week the symptoms may rapidly subside and the enlargement of the gland disappear, or suppuration occurs, attended with increased pains, which assume a throbbing character, and chills which occur on one or more evenings. The purulent degeneration then proceeds rapidly, and distinct fluctuation is felt per rectum in three to four days. If the process is left to itself perforation sets in, the capsule in which the pus is situated yielding at some point. If this is towards the urethra the pus will empty into the latter. The patient then experiences an acute pain, usually during defecation or micturition, and a stream of bloody pus flows from the urethra. The rupture is followed by rapid remission of all the symptoms.

Or the capsule ruptures at some other point and the pus passes into the loose cellular tissue and between the fasciæ of the pelvis. It may make its way either toward the rectum, into which it perforates, or towards the perineum. Here a swelling forms, above which the skin reddens and softens, and rupture takes place. Various remarkable paths may also be followed by the pus. Among 102 cases, collated by Segond (1880), the discharge occurred in

64	cases	into the	urethra.	
43	"	"	"	rectum.
15	"	"	"	perineum.
8	"	"	"	ischio-rectal fossa.
3	"	"	"	inguinal region.
2	"	through the	obturator foramen.	
1	case	"	"	umbilicus.
1	"	"	"	sciatic foramen.
1	"	at the edge of the false ribs.		
1	"	into the abdominal cavity.		
1	"	"	"	cavity of Retzius.

In simple cases the formation of granulations now begins in the abscess cavity, and rapid recovery follows.

But the proximity of the urethra, bladder and rectum

furnish so many dangers for inoculation, which may also occur from the outside. And so the entrance of urine or fæces, and therefore urinary infiltration, septic infection, gangrene and pyæmia, are not uncommon terminations.

Coincident perforation into the urethra and the rectum or perineum may form an unnatural passage for the urine, which may lead to infiltration or the development of annoying fistulæ.

Parenchymatous prostatitis is, therefore, a very serious affection. Among Segond's 114 cases recovery occurred in 70 cases; death occurred in 34 cases; urinary fistulæ occurred in 10 cases.

In addition to the termination in complete resolution and in suppuration there is a third and rarer termination, *viz.*, induration. The acute symptoms and subjective phenomena disappear, but rectal examination shows that the prostate is distinctly enlarged and firm. This enlargement may diminish gradually, or it is followed by hypertrophy of the prostate.

Unlike the acute forms just described some cases run an insidious, torpid course. Some external injury is followed by slight vesical tenesmus, which is not very annoying to the patient. Local remedies are discontinued, but the secretion remains profuse. Five or six days later, during which time the patient attends to business, and can ride, walk and sit without difficulty, chill and fever set in, with some pain in urination and defecation. On examination per rectum we are greatly astonished to find a large, already fluctuating enlargement of the prostate. Pitman describes a case of this kind and I have observed several, so that I lay it down as a rule that the prostate should be examined at once whenever fever occurs during the course of gonorrhœa.

Periprostatic Phlegmons.—Paupert, Parmentier and Dubrueil call attention to the fact that inflammation of the periprostatic tissue results not so very rarely from the same causes as parenchymatous prostatitis. The prostate is surrounded by firm cellular tissue, especially behind and below. Collections of pus form here, and first extend upward between the prostate and rectum, and may even separate the peritoneum. The pus then usually seeks the perineum and may perforate here or even into the bulb of the urethra. It forms more rarely between the prostate and the urethra. The

symptoms are very like those of acute prostatitis; the diagnosis is based on examination per rectum which shows that the prostate is intact. As rupture occurs usually into the perineum, more rarely into the rectum, the course is generally favorable, and urinary infiltration and gangrene are not so much to be feared.

Chronic Prostatitis.

This may develop as the residuum of acute, especially follicular, prostatitis, or may begin as a chronic affection as a complication of chronic urethritis. It is so closely connected with the symptomatology of one of the forms of chronic posterior urethritis that we have already described it. I will here content myself with recalling attention to the cardinal symptoms, prostatorrhœa and sexual neurasthenia, without entering again into a detailed description.

Pathological Anatomy

Apart from the older autopsies, which refer chiefly to suppurating prostatitis, we owe our knowledge of the pathological anatomy to Home, Hamilton and Thompson, though it is still defective on account of the lack of sufficient material. Thompson describes the changes in acute prostatitis as follows: The prostate is swollen to three or four times the normal, and feels firm and tough. The arteries are filled with dark blood, and the mucous membrane of the pars prostatica is dark red. On section the tissues appear redder than normal. Pressure expresses a large amount of reddish fluid, which is found, under the microscope, to consist of lymph, blood, prostatic fluid, and a small amount of pus. As the inflammation progresses the amount of pus increases, and on section through the lobes of the prostate, small drops of pus emerge from the glands. In advanced stages we find more or less numerous foci of pus, from the size of a hemp-seed to that of a pea, scattered through the substance of the prostate. This pus has one peculiarity, *viz.*, that it is mucous, sticky, and mixed with blood. The prostate may be softened and gangrenous in small spots, the mucous membrane of the urethra is reddened and thickened, perhaps covered by false membranes, or it is partly destroyed

by ulceration or gangrene. One or more of the purulent foci in the prostate empty directly upon the mucous membrane.

In chronic prostatitis Thompson found the prostate sometimes enlarged, sometimes very small, its consistence softened, even spongy. A section has a dark red to violet color, pressure discharges abundant dark fluid. In advanced cases circumscribed deposits of pus are found, perhaps as large as a hemp-seed. The mucous membrane of the pars prostatica is thinned and very vascular, the openings of the prostatic glands are extremely large; more rarely the mucous membrane is thickened and has a livid red color. Pus is found not infrequently in the sinus pocularis, the excretory ducts of the glands, and in small cavities which communicate with the urethra, and also in cavities within the periprostatic cellular tissue. In Fuerbringer's (1884) case, the gland was enlarged and infiltrated with broad, firm, ivory-white bands of cicatricial connective tissue. The walls of the excretory ducts were hyperplastic and infiltrated with small cells; the ducts were distended with an opaque mucous fluid like that described in the symptomatology of prostatorrhœa. The glandular tissue proper presented, in places, marked swelling and cloudiness of the epithelium with pronounced interstitial inflammation; no abscesses.

Diagnosis and Prognosis.

Acute prostatitis presents such typical symptoms that its diagnosis is unattended with difficulty. The only disease which may present analogous symptoms at the start is acute posterior urethritis, and this indeed takes part in the symptomatology of prostatitis. The differential diagnosis is made by examination per rectum, which should, therefore, not be neglected in any case of acute urethritis posterior. It is in this way alone that we can detect recent congestions and follicular inflammations, and thus prevent more serious parenchymatous inflammations.

The diagnosis of chronic prostatitis can be made at once by examination of the prostatorrhœic secretion, examination with the endoscope and sound, testing the urine, and by the recognition of sexual neurasthenia.

The prognosis of acute prostatitis should be guarded. The congestion and follicular inflammation and many parenchy-

matous inflammations terminate in resolution, but the effects of the latter form, which are not always under our control, are so serious that caution is advisable, even if the process is running a favorable course.

This is also true of chronic prostatitis, especially in view of the fact that the neurasthenia, which so frequently accompanies it, may persist after recovery of the local symptoms.

Treatment.

Acute Prostatitis.—The chief point in every inflammation is rest. And so in acute prostatitis we must secure rest in bed, and also rest for the organ, *i.e.*, avoid injections, give the well-known antaphrodisiacs (*vide* Treatment of Gonorrhœa) and secure easy and regular evacuations from the bowels. Strict antiphlogosis is indicated so long as suppuration cannot be found. All former measures have become superfluous since I devised an apparatus which permits the local application of cold. This (Fig. 27) is analogous to Arzberger's hemorrhoidal apparatus. It consists of a narrow metallic tip, 16 cm. long, whose cavity is divided into two parts by a septum extending almost to the end, and is connected with two tubes. The well-oiled tip is inserted into the rectum, the widest portion resting directly on the prostate. Cold, or even ice-cold, water is now allowed to flow through by syphon action, and this cold is conveyed to the prostate. This apparatus, applied for an hour two or three times daily, has done excellent service so long as suppuration was not noticeable. Two days' use suffices to dispel the inflammation, even in acute and considerable swellings. At the same time the instrument is easily inserted by the patient himself. In addition, further antiphlogistic and symptomatic treatment may be carried out. For example, inunctions of gray ointment to the perineum; if the pains and tenesmus are violent morphine internally, subcutaneously and as suppository. Narcotics are given to relieve the retention of urine, which, like the swelling, depends in great part on the spasm of the sphincters. It is only in case of urgent necessity that an elastic, narrow catheter is carefully passed into the bladder, but is then allowed to remain. If suppuration sets in, the case must be treated according to surgical principles. An opening should be made, if possible from the

perineum. At all events this is to be preferred to opening the abscess with the catheter from the urethra. If possible, *i.e.*, if the catheter in such a case does not catch in the opened abscess cavity, a catheter *à demeure* is inserted after the rupture into the urethra has taken place.

FIG. 27.

Chronic Prostatitis.—In this form the treatment of the prostatorrhœa and chronic urethritis is the most important.

The prostatorrhœa may be treated by the use of Winternitz's psychrophore, which I have previously described. In many cases the apparatus shown in Fig. 27 has been very use-

ful, but instead of cold water I apply warm water (37 to 42° C.) for an hour every day. Good results are also obtained from the subsequent application of the following suppositories:

℞	Potass. iodid., ...	gr. vij
	Iodin. p., ...	gr. ¾
	Extr. belladon., ...	gr. j
	Butyr. cacao q. s. f. suppositor. No. V.	

The urethral treatment consists of the application of solutions of nitrate of silver (1 to 5 per cent.) or potassium-iodide iodine-lanolin ointments, particularly the latter. Good results often follow the introduction of sounds of large calibre.

The neurasthenia is often cured by the local treatment of the prostatitis. If neurasthenic symptoms remain after recovery from the prostatitis and chronic urethritis, they are to be treated by the cold-water cure, iron and arsenic, sea bathing, Playfair's cure, according to the severity of the process.

V. INFLAMMATION OF THE EPIDIDYMIS.

General Remarks.

The knowledge of this, the most frequent complication of the blenorrhagic process, is almost as ancient as that of gonorrhœa itself. But we possess no accurate data concerning the frequency of its occurrence.

Rollet observed 678 cases of epididymitis (27.9 per cent.) among 2425 cases of clap; Jullien 381 (15.2 per cent.) among 2500 cases; Tarnowsky 673 (12.2 per cent.) among 5203 cases, and I observed during a five years' hospital service, 548 (29.9 per cent.) epididymitides among 1844 cases of urethritis. But all these figures are derived from hospital material, and hence are certainly too high, because it seems evident *à priori* that patients suffering from epididymitis, being unable to work, will then enter the hospital in larger numbers than those suffering from simple urethritis. In fact, Berg, taking his statistics from private practice, states that he has seen epididymitis in 7.5 per cent. of all urethritides.

In the large majority of cases epididymitis is unilateral. It was maintained formerly that there is a great predominance on the left side, and various explanations were offered, for example, that the majority of men "dress" on the left side, so

that the left testicle is exposed more readily to pressure and contusions. The predominance of left varicocele, the pressure exerted by the sigmoid flexure on the left vas deferens, were also mentioned as factors. But examination of a large statistical material shows that the difference between both sides is very small and requires no explanation.

The situation of the epididymitis is given as follows:

	Right side.	Left side.	Both sides.	Total.
Gaussaille,	45	24	4	73
D'Espiné,	12	11	6	29
Aubry,	40	52	7	99
Castelnau,	125	133	7	265
Curling,	21	14	1	36
Sigmund,	60	48	6	114
Fournier,	102	126	35	263
Turati,	191	192	25	408
Le Fort,	249	200	41	490
Ramorino,	29	37	—	66
Gamberini,	15	10	3	28
Breda,	64	53	4	121
Jullien,	167	182	33	382
Kuehn,	70	67	12	149
Unterberger,	35	25	5	65
Author,	275	251	22	548
	1500	1425	211	3136

From these tables it appears that the difference between the two sides is extremely small, and that bilateral epididymitis is rare.

This complication results from the direct continuation of the blenorrhagic process, and will only develop after the process has reached the pars posterior. Hence the earliest period, as a rule, is the end of the second or beginning of the third week. Exceptions may arise if the gonorrhœal pus is carried mechanically, at an earlier period, into the pars posterior, here produces inflammation and propagation to the epididymis. The statistics of Fournier, Le Fort, Gaussaille, D'Espiné, Aubry, Castelnau and Unterberger give the following results with regard to the onset of epididymis:

1 week	after	infection	in	. . .	46 cases.
2 weeks	"	"		. . .	157 "
3 "	"	"		. . .	132 "
4 "	"	"		. . .	191 "
5 "	"	"		. . .	132 "
6 "	"	"		. . .	64 "
7 "	"	"		. . .	44 "
8 "	"	"		. . .	61 "
3 months	"	"		. . .	66 "
4 "	"	"		. . .	33 "
5 "	"	"		. . .	18 "
6 "	"	"		. . .	22 "
7 "	"	"		. . .	9 "
8 "	"	"		. . .	8 "
9 "	"	"		. . .	5 "
10 to 12 "	"	"		. . .	8 "
2 years	"	"		. . .	9 "
3 "	"	"		. . .	7 "
4 "	"	"		. . .	2 "
7 "	"	"		. . .	1 case.
					1015 cases.

Hence more than half of the cases (612 out of 1015) began two to five weeks after infection, and absolutely the largest number (191 cases) in the fourth week. Vidal and Sturgis also report the earlier occurrence of epididymitis, and even so critical and experienced an observer as Bergh states that in two of his cases the epididymitis developed soon after exhausting coitus, a few days before the discharge began, and in two others began with the discharge during the first week. Nevertheless I am extremely skeptical concerning such statements, not that the patient always intends to deceive us, but how many individuals suffer from chronic posterior urethritis without knowing it, and cannot this produce epididymitis when an exacerbation results from pronounced morbific influences?

All those causes which give rise to exacerbations of urethritis, and which we have frequently referred to, also give rise to the development of epididymitis. Le Fort's statistics are interesting with regard to the statement so frequently made that the treatment of gonorrhœa is the chief cause of the de-

velopment of epididymitis. 576 cases were classified as follows according to the previous treatment:

No treatment, ...	264	cases.
Balsams alone, ...	73	"
Injections alone, ...	82	"
Balsams and injections, ...	60	"
Treatment unknown, ...	97	"

The untreated cases, accordingly, are those in which epididymitis is most frequent. This is probably not due exclusively to the absence of treatment, but it is to be assumed that careless patients will add positive injurious influences to the negative one of absence of treatment. These include excesses in Baccho et venere, bodily strain, improper treatment.

Desfries (1878) attributes epididymitis to the retention of semen resulting from the continence rendered necessary by the blenorrhœa. It is true that individuals who remain continent during a long-continued blenorrhœa, suffer from pain along the vas deferens, dragging and heaviness in the testicles (seminal colic), but these are not apt to be mistaken for epididymitis, and we therefore adhere to the old view that this complication results much more often from losses than from retention of semen.

Symptomatology.

Acute epididymitis usually begins brusquely. A violent pain in the testicle is suddenly felt, "as if molten lead had dropped into the testicle," fever and malaise set in, and the disease is fully developed at the end of a few hours.

In rarer cases prodromal symptoms are observed. The patients complain of general malaise, slight chilliness, and anorexia; then vesical tenesmus appears, with pain in the inguinal region, near the external ring, radiating towards the testicle and kidney, and finally persisting in the testicle. The secretion, which had been abundant hitherto, usually ceases. Among 141 cases examined by Aubry, the urethral secretion disappeared in 81, was materially diminished in 58 cases, and in only 2 cases did it increase with the onset of the epididymitis.

The most constant, often the sole symptom, is a suddenly occurring, fixed pain in one testicle. On palpation the patient

usually feels a swelling as large as a hazel nut or walnut. This swelling is confined at first to the head, more rarely to the tail of the epididymis, is sharply defined, and is extremely painful on palpation.

The swelling extends very rapidly to the entire epididymis, and within twenty-four hours from the beginning of the affection the enlargement is visible to the eye, the integument of the affected side of the scrotum is red, warm and tense. On examination the normal testicle is found surrounded above, behind, and below by a semilunar, moderately firm and extremely painful swelling, the inflamed epididymis.

In many cases the process remains at this stage. The enlargement and tenderness of the epididymis and the violent spontaneous pains increase for a few days. The patient, unable to move on account of the threatened exacerbation of the pains, assumes the dorsal position in bed, and supports the affected side by drawing upon it by partial flexion of the corresponding lower limb. In a few days the pains disappear spontaneously, the inflammatory stage is over.

In other cases the inflammation and swelling are not confined to the epididymis. It extends per continuitatem to the spermatic cord, attacking particularly the vas deferens. The latter appears firmer than normal, is tender on pressure, and can be traced into the external inguinal ring as a round cord as thick as a raven's quill. In some cases it can also be followed, per rectum, to the prostate as a firm, tender cord, and even the corresponding half of the prostate appears enlarged, firm and tender.

The entire spermatic cord may also take part in the inflammation. It is then swollen and shortened, so that the affected testicle is drawn against the inguinal ring, and is the site of violent pains.

The inflammation may also extend to the tunica vaginalis, where it gives rise to increased effusion of fluid. At first the tunica vaginalis testis alone is attacked. Fluid escapes between the two layers, an acute hydrocele testis develops. The size of the affected half of the scrotum is materially enlarged by this very considerable and rapidly increasing swelling. The testicle itself can no longer be felt. It is enclosed in front and on the sides by a tense fluctuating tumor, behind which is the firm enlargement of the epididymis.

If, as a developmental anomaly, the two layers of the tunica vaginalis of the spermatic cord are not firmly adherent, an acute exudation may form between them, hydrocele acuta funiculi spermatici. We then find a fluctuating, tense, sausage-shaped tumor, which ends at the external inguinal ring.

When the swelling has thus attained considerable dimensions, the integument of the corresponding half of the scrotum does not remain entirely intact. It is stretched tightly over the tumor, and is also reddened, swollen, and adherent to the subcutaneous tissues (eczema glabrum).

In such a case all the tissues of the affected half of the scrotum participate in the inflammation. Concerning the condition of the testicle, which is concealed on all sides, we can obtain no information, but it appears to be the least affected of all.

All these changes may develop rapidly. The disease reaches its acme in four to five days, remains *in statu quo* for a few days, and then subsides, the inflammatory symptoms disappearing rapidly, while the swelling is absorbed very slowly.

The course just described presents numerous variations.

In the first place the onset of epididymitis may be very violent.

The patient, who is suffering from acute urethritis, exposes himself to some injury, and at the end of twelve to twenty-four hours is attacked, towards evening, by violent pains which cannot be localized accurately and involve the entire abdomen. The lower part of the abdomen is tympanitic, tense, and extremely sensitive to touch, even to the pressure of the bed-clothes. There is high fever, reaching to 39.5° C or even 40° C. The pains increase from hour to hour, radiate into the sacral region and thighs; eructations, singultus, nausea set in, finally vomiting of greenish bile-stained mucus, and collapse. The symptoms create the impression of foudroyant peritonitis, and internal incarceration is suspected. Acute delirium tremens may occur in drinkers. On the following morning, when the symptoms have subsided, the swelling of the epididymis is apparent. Unlike these acute prodromal symptoms, the epididymitis which supervenes is not always very acute, but may be confined to the epididymis or a portion of it. In these cases we evidently have to deal with symptoms of violent peritoneal irritation. Hunter was the first to direct attention to them.

We have stated that the disease begins in the epididymis, whence it extends upwards to the vas deferens and prostate. In rare cases the process is reversed, the disease pursues a descending course. After vesical tenesmus and cessation of the secretion a partial swelling of the prostate occurs, confined to one lobe. The vas deferens, swollen to the size of a raven's quill, can soon be felt to one side, and it is not until three or four days later that a circumscribed and moderately painful swelling of the epididymis develops. This may increase to an acute extensive epididymitis as the result of external causes. In a few cases I have been able to confirm Bergh's observations on this point.

The blenorrhagic inflammation may even be confined to the vas deferens, constituting pure chordonitis blenorrhagica. J. Bell (1794) was the first who observed a few cases of this kind. In one of these, which was carefully described, the patient, whose gonorrhœal secretion suddenly ceased, began to complain of violent pain at the neck of the bladder, extending towards the inguinal region and the testicle. A tumor suddenly developed below the inguinal ring, at first as thick as a raven's quill, and could be traced as far as the epididymis. The latter as well as the testicle was unaffected. The tumor rapidly increased in thickness until it was an inch in diameter, had an elongated, round, almost spindle shape, and extended to the upper part of the testicle. Gosselin reports another case. In a man of twenty-five years, who had suffered from blenorrhœa for five months, a swelling formed in the scrotum at the level of the head of the epididymis. It formed a nodule as large as a hazel nut, terminating above in a cord as thick as a raven's quill, and could be separated from the epididymis. Rectal examination showed nothing abnormal. Bergh describes a similar case. Kohn's patient, a servant suffering from urethritis, suddenly experienced pain in the right side of the scrotum after a paroxysm of coughing. This increased, and fever, constipation and vomiting were superadded. A cylindrical tumor developed in the right inguinal region, beginning at the external inguinal ring, passing into the right half of the scrotum without sharply defined boundary, and corresponding to the course of the right spermatic cord. The right testis and epididymis appeared intact. The vas deferens, normal below, passes into the tumor, the skin over it is tightly

stretched, and its temperature is elevated. Pain in the tumor spontaneously, and on pressure and coughing. The tumor gradually disappeared, leaving a cord as thick as catgut which was recognized as the spermatic cord.

An equally rare form is disease of a vas aberrans. Gosselin describes the case of a young man in whom, during the third week of an acute urethritis, a painful tumor developed in the scrotum, as large as a hazel nut and completely free; its pedicle could be followed to the neighborhood of the epididymis and the origin of the vas deferens.

Further varieties are created by changes in the position of the testis and epididymis.

These may occur within the scrotum, the mutual relation of the testis and epididymis being changed by rotation around the horizontal and vertical axes. Royet distinguishes five forms:

1. The epididymis is situated in front of the testis.
2. It is on the outer or inner side of the testis.
3. The testis is rotated around a horizontal axis, passing from right to left, and the epididymis is situated above the testis.
4. Under the same conditions the epididymis may be situated below the testis.
5. The position of the two organs is subject to constant change.

During a great part of fœtal life the testicle remains in the abdominal cavity and descends through the inguinal canal into the scrotum at a late period. Now, it may happen that the testicle remains in the inguinal canal, or it may go too far and pass into the perineum, where it remains on one side of the raphe, or finally it may emerge through the femoral ring and remain fixed beneath Poupart's ligament. A testicle situated in such an abnormal position may be attacked during the course of a blenorrhagic inflammation.

The most frequent form is intrainguinal epididymitis. MM. Robert, Paris and Bouchard have described cases of this kind. In mild cases the patient complains of pain in the groin, and a painful swelling, covered by reddened skin, appears there, but rapidly subsides after rest and antiphlogosis. In severer cases the tumor is as large as a hen's egg or goose egg, with the long diameter parallel to Poupart's ligament. It consists

of two distinct parts, one of which is semilunar in shape, situated to the outside and below, firm, the other is situated above and within, is oval and elastic, creating almost the impression of fluctuation. If the spermatic cord forms a loop which dips into the scrotum, it is swollen and tender. The inflammation may also extend to the tunica vaginalis, serous effusion forms and presents distinct fluctuation. When the tunica vaginalis communicates with the abdominal cavity circumscribed or general peritonitis may develop. On examination of the corresponding half of the scrotum the testicle is found to be absent, and the patient not infrequently tells us that there had formerly been an oval swelling in the groin. This variety, like subcrural epididymitis, is apt to be mistaken for a bubo, while perineal epididymitis may simulate Cowperitis or a periurethral abscess. Examination of the scrotum and the demonstration of both testicles or the absence of one, form the decisive diagnostic factor.

A further complication, which was carefully studied by Ledouble, is owing to the fact that the corresponding half of the scrotum contains a hernia or varicocele in addition to the testicle. The tail of the swollen epididymis is apt to adhere to the hernia so that the latter becomes irreducible, and the inflammation may also extend to the peritoneum of the protruding gut, giving rise to symptoms of incarceration and peritonitis.

The inflamed epididymis may also become adherent to a varicocele, causing an exacerbation of the latter.

The most favorable termination of epididymitis is recovery. Although this takes place in the majority of cases, complete *restitutio ad integrum* is a comparatively rare event.

It is true that the inflammatory symptoms disappear and the swelling diminishes, but the absorption of the infiltration is incomplete. In some portion of the epididymis, usually the head, a nodule remains, as large as a pea or even larger, firm, sharply defined, and causing little annoyance to the patient.

New injuries occurring during the course of the urethritis may be followed by a relapse starting from this nodule, but finally the process remains stationary.

In other cases a diffuse uniform thickening of the head or tail of the epididymis remains, and testifies for years to the process which has run its course.

These residua of epididymitis may remain in any part in which the acute inflammation has been seated. In the vas deferens this is shown by the persistence of a firm, painful cord, in the tunica vaginalis by the fact that only a part of the acute exudation is absorbed while the rest remains in the form of chronic hydrocele.

A rarer and, naturally, much more serious termination is suppuration. Starting from the height of the process, which is then extensive and associated with acute hydrocele and eczema glabrum, one or more abscesses develop, attended with fever and violent pain. The abscesses cause bulging of the skin, finally rupture, and discharge crumbly pus. This is attended usually with the evacuation of a yellowish, bunched mass, which appears to consist of separate threads. When these threads are pulled upon, they may be drawn out to a considerable length. This is the coil of the tubules of the epididymis. If only one abscess forms and then heals—this is attended usually by funnel-shaped retraction of the skin—a portion of the epididymis and testis may remain intact. But if several abscesses form, the entire contents of one half of the scrotum are usually destroyed by purulent degeneration and elimination.

In other cases the process assumes a chronic course after perforation externally has occurred. The perforations are then converted into fistulous openings which discharge small amounts of crumbly pus, but the destruction continues for a very long time. In this way a large part of the testicle and epididymis is eliminated. The integument of the scrotum usually becomes thickened by chronic inflammation, its folds become very prominent, and hidden between them are the fistulous openings, which are often retracted into a funnel shape.

Finally, in tuberculous and syphilitic individuals blenorrhagic epididymitis may furnish the starting-point for the development of corresponding tuberculous and syphilitic changes.

The course of bilateral epididymitis, which is a rare disease, is exactly like that of the unilateral affection. The inflammation rarely develops at the same time on both sides, but usually begins in one testicle while the other is recovering. It happens not infrequently that after recovery of the former the one first affected is again attacked.

An important question refers to the seminal changes resulting from disease of the organs which produce and convey the semen. These can be better studied in bilateral epididymitis, because in unilateral disease the other side produces normal semen.

In the acute stage, during which pollutions are not uncommon, the semen is found to have a yellow or yellowish-green color from the beginning of the inflammation, and leaves stains upon the clothing which have the central gray color of normal semen, while there is a yellow ring, like pus, at the periphery. In addition to the ordinary cellular elements of the semen microscopical examination shows multinuclear pus corpuscles in larger or smaller numbers. In unilateral epididymitis spermatozoa are usually present in large numbers, living and well developed, in bilateral epididymitis they are generally absent from the second or third day of the disease. In the acute stage, after the urethral suppuration has ceased entirely and the urine is clear, the pus which is mixed with the semen cannot come from the urinary passages—as may be seen in pollutions during the acute stage of a simple anterior urethritis—but must be derived from the seminal passages. Fuerbringer states that the pus is due to catarrh of these parts. As the acute symptoms disappear, the amount of pus in the semen diminishes, the latter often becomes peculiarly thin, and the spermatozoa often remain absent for several months. This is usually associated with diminution of sexual desire. The spermatozoa finally return.

More important, because often permanent, are the changes induced by the infiltrations and thickenings which are left over. These thickenings, consisting of connective tissue which grows constantly firmer, enclose the excretory canals, and may thus prevent the passage of semen from the testicle. Gosselin's injection experiments have shown that this compression of the ducts of the epididymis is very often complete, but not infrequently consists merely of narrowing of the canals. If a fibrous nodule is situated in the head of the epididymis it is relatively innocuous, because sufficient semen can escape through the middle portion and tail. When it is situated in the tail the conditions are much more unfavorable, the interference is more marked, perhaps even complete.

If one epididymis alone is diseased, the other performs its

function regularly, indeed it might be expected to act vicariously. But this does not happen in all cases. At least Jullien states that in the acute stage of certain unilateral epididymitides, when the other testicle and epididymis appeared to be entirely normal, he found complete absence of spermatozoa, and that after the disappearance of the inflammatory symptoms he has observed marked oligaspermia, which often lasted a long time.

In 85 cases of bilateral epididymitis, followed by indurations, Gosselin, Godard, Liégeois and Jullien found only 9 in which the spermatozoa returned, in the other 76 cases aspermatism remained. It is questionable whether this is permanent. At least Horand reports concerning several individuals who, although suffering from old bilateral indurations, became fathers of a numerous progeny. Gosselin made the interesting observation in these cases of aspermatism that the semen retains its external characteristics, consistence, amount, odor,—facts which are explained by Fuerbringer's investigations on the composition of the semen.

Unilateral suppuration of the testicle does not interfere permanently with the function of the other testicle; the potentia generandi and cœundi is retained. Bilateral suppuration causes impotentia generandi. The ability to perform coitus need not suffer, as is shown by Bjoerken's case. A man, æt. twenty-three years, who lost both testicles in rapid succession from suppurating epididymitis, performed coitus and had pollutions after recovery. The ejaculation did not contain spermatozoa.

Pathological Anatomy.

While the relative frequency of this complication and its serious significance were the cause of our early knowledge of this condition, it also led, on the other hand, to frequent opportunities for anatomical examinations.

Nevertheless one error was carried down to the beginning of the present century, to which the disease owes its popular name of "swelled testicle." The site of the disease was located in the testicle, and the affection was called blenorrhagic orchitis. So far as I know, Monteggia (1804) was the first to make an autopsy in a case of epididymitis, and noted that the testicle was unaffected. He gives the following description: "The

tunica vaginalis was adherent to the albuginea, and a yellow purulent fluid was found below between the inflamed and thickened membranes. These membranes were more adherent than in the normal condition. The membranes of the dartos were also hard, thickened and inflamed. The testicle itself was normal and not in the least thickened. In that portion of the tunica vaginalis which is usually prolonged behind the epididymis, was found a cavity containing a soft yellow substance, which was probably derived from exuded inflammatory lymph. The entire prostate had undergone suppuration and was separated into different divisions by a number of pus cavities. These abscesses opened into the urethra in three places; twice at the sides of the caput gallinaginis, and also further back towards the neck of the bladder. The pus had also pushed back the capsule of the prostate and formed a large pus cavity between the neck of the bladder and the rectum."

Gaussaille published the reports of two autopsies. In the first the epididymis was twice its normal size, firm and hard. The testicle also appeared to be doubled in size, but this was found, on section, to be due to an accumulation of thick, cloudy, slightly bloody serum between the layers of the tunica vaginalis testis. The albuginea was thickened, and traversed by dendritic vessels. The substance of the testicle showed no notable changes.

In the second case both vesiculæ seminales were swollen and firm, and the vasa deferentia also showed traces of inflammation. The epididymes were enlarged on both sides and of a wine red color, the testicles were normal in size; a small amount of fluid in the tunica vaginalis.

Based on these investigations and on their observations in the living, Rochoux and Ricord declared: "Pas d'affection blenorrhagique des organes contenus dans les bourses sans engorgement de l'épididyme," and the truth of this statement is generally recognized at the present time.

Velpeau made an autopsy on a man of twenty-two years who died of cholera, and had suffered for eighteen days from epididymitis. He found the tunica vaginalis, testicle, and the head and body of the epididymis, normal. In the tail was a nodule as large as a bean, which was yellow on section. The last convolutions of the vas deferens and epididymis appeared

dilated, and contained pus. No spermatozoa were found in the vas deferens and corresponding seminal vesicle.

In cases of intrainguinal epididymitis Paris found the tunica vaginalis adherent to the testicle and covered with false membranes, the testicle apparently normal, but without seminal elements, and usually atrophic. In Gosselin's case the testicle was in the inguinal canal, the epididymis had descended into the scrotum, was considerably swollen, and infiltrated with foci of pus.

In two cases Godard found the seminal vesicle on the diseased side smaller than on the other, and there were no spermatozoa in the vas deferens, while they were abundant on the healthy side.

Schepelern reports an interesting case. A sailor, æt. seventeen years, who had suffered for three weeks from blenorrhœa, and for eight days from left epididymitis, was suddenly attacked by right-sided peritoneal symptoms and died in thirty-six hours.

The autopsy showed that the cause of death was typhlitis, perforation of the vermiform appendix and peritonitis.

The urethra was reddened, especially in the most posterior portion. The entire left vas deferens was half again as thick as the right, its vessels were injected and tortuous, the cauda of the left epididymis was swollen, infiltrated, firmly fibrous, and the anterior portion contained a collection of pus as large as a pea. The remainder of the epididymis was somewhat enlarged, the testicle was normal. In the tunica vaginalis was a small quantity of fluid, and beginning adhesive inflammation corresponding to the cauda. The tunica propria was thickened, and adherent to the lower part of the scrotum. Microscopic examination showed slight catarrh of the vas deferens.

Finally, we owe to Rougon the history of the following interesting case. An artillery officer, æt. thirty-five years, is brought to the hospital in a dying condition. The skin is cold and clammy, the face pinched, the pulse rapid, small and thready; pain in the head, thirst, nausea, vomiting of bile. The abdomen tense and painful, especially in the region of the right iliac fossa. Right-sided epididymitis with acute hydrocele of the tunica vaginalis. The autopsy showed: the abdomen distended with gas, ecchymoses in subperitoneal cellular tissue on right side. Peritoneum covered with false mem-

branes, especially in the right iliac fossa; about 300 grm. sero-purulent fluid in the iliac fossa and pelvis, 100 gr. sero-purulent fluid in the right tunica vaginalis propria testis, the membrane injected, and covered here and there with false membranes. The right epididymis swollen, reddened, ecchymotic, containing spots of pus on section. The right spermatic cord thickened, with exudation in its coverings.

The almost complete picture of epididymitis furnished by these autopsies is supplemented by the investigations of Malassez and Terillon. In beginning epididymitis they found the epithelium of the seminal canals in a condition of cloudy swelling and destitute of cilia, the remaining tissues normal. A higher grade is characterized by œdema of the walls with small cell infiltration. In still more advanced stages the loose tissue around the seminal canals is infiltrated and swollen, the canals themselves are filled with a yellowish-green fluid, consisting of semen and pus. The nodules of the advanced stages are formed of densely infiltrated connective tissue surrounding the seminal canals.

Diagnosis, Prognosis.

The symptomatology is so characteristic that there can hardly be any doubt concerning the nature of the affection in the majority of cases. In cases of abnormal position the knowledge of this fact, together with examination of the scrotum, which should never be neglected, as regards the presence of both testicles, suffice for the diagnosis.

The prognosis is favorable in the majority of cases. The possibility of suppuration or peritonitis should make us cautious in giving a prognosis in feeble, cachectic individuals, or when the inflammatory phenomena are very severe.

Treatment.

Unlike the changing principles of treatment of gonorrhœa and its complications, the treatment of epididymitis has remained tolerably stable. The methods varied only between the limits of antiphlogistic treatment. The first thought would be to diminish the swelling or prevent its increase by exercising external compression, and so this plan was adopted

after that of abstraction of blood, which was so prevalent at the beginning of the century. The oldest of these methods is that of Fricke, who performed compression by means of strips of adhesive plaster. The testicle and epididymis of the diseased side were first grasped separately in the corresponding half of the scrotum and prevented from slipping by an encircling strip which compressed the scrotum immediately above them. Then follows a series of vertical strips, about

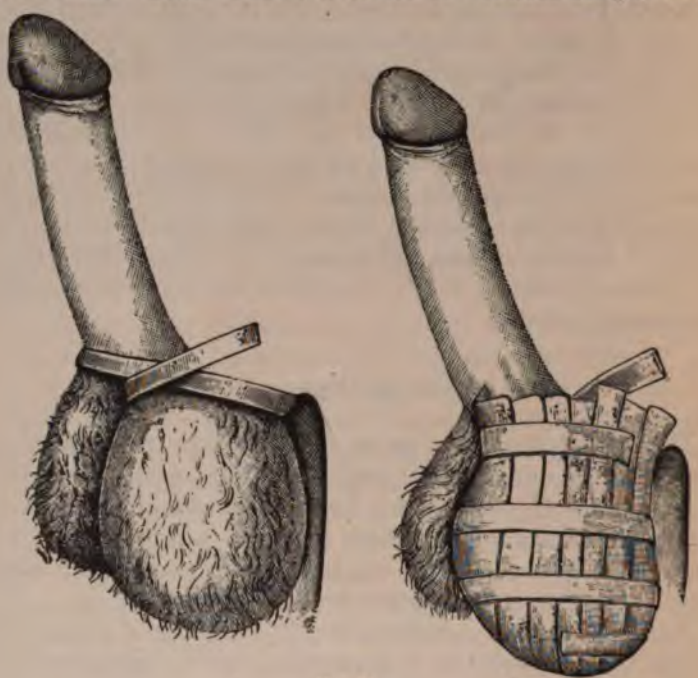

Fig. 28.

the width of the finger and overlapping like shingles, which cross at the lower extremity of the scrotum, and thus form a firmly adherent cap. These are secured by one or more encircling strips. Employed originally in recent epididymitis, this method, which is still used occasionally, is confined generally to the second stage when the inflammatory symptoms have disappeared and the swelling alone remains. This dressing aids resorption materially, but it possesses the disadvantage that, when applied too tightly, it produces pain or causes atrophy of the testicle, and when applied loosely, has little

effect and must be frequently changed. This is painful, because the dressing adheres firmly to the hairs on the scrotum. White's dressing is a modification of Fricke's. Miliano's compressing suspensory (Fig. 29) acts in a similar manner though not so brusquely. It consists of a knitted sac, fitting one half the scrotum, provided with straps, the tightening of which

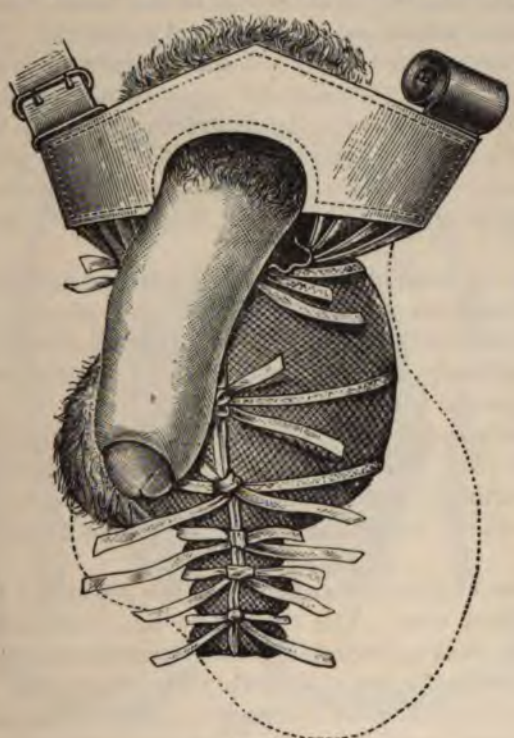

Fig. 29.

enables us to produce moderate compression of the testicle and epididymis.

A series of applications to the scrotum also produce compression. These are usually of an irritating or caustic nature, and cause compression by means of reflex contraction of the tunica dartos. These include the application of nitric acid, collodion, concentrated solutions of nitrate of silver (1:20), sulphuric ether, and tincture of iodine.

The diminution of the tension was also regarded as anti-

phlogistic, especially in those cases in which fluid had accumulated in the tunica vaginalis. Velpeau recommended puncture of the tunica vaginalis with a bistoury for this purpose. This is a harmless method, which usually produces immediate relief, but is followed unfortunately by a fresh accumulation of fluid.

Vidal recommended a more vigorous plan, *viz.*, debridement, or splitting of the coverings of the testicle down to the tunica vaginalis over an extent of 1.5 to 2.0 cm. This treatment was abandoned after several cases were reported in which it had been followed by suppuration, gangrene, and elimination of the testicle. In recent times Smith, Ragazzoni, Appiani, and Nunn have again recommended punctures, partly simple, partly extending to the tunica vaginalis. Jobert injects several drops of tincture of iodine into the tunica vaginalis.

Watson Spencer follows puncture with an adhesive-plaster dressing. Bonnière scarifies, applies ice compresses and, when the integument of the scrotum has contracted, a knitted, snugly fitting suspensory, which is smeared with rapidly drying glue in order to make it more resisting.

Cold has also been applied locally in the shape of cold compresses and ice. This is an extremely vigorous antiphlogistic, but the continued application of ice gives rise to extremely firm infiltrations, which then resist absorbent treatment for a long time.

All these cumbersome apparatus are generally abandoned at the present time. The conviction has been reached that epididymitis runs a favorable course spontaneously, and that in the majority of cases it is merely the duty of the physician to keep hurtful factors at a distance. Rest in bed, and an elevated, guarded position of the scrotum by placing beneath it a compress or handkerchief, suffice to diminish the pains and secure a favorable termination. Regular evacuations from the bowels and fever diet will do the rest. The pollutions are treated in the usual way. Frequently changed compresses of cold water are useful, but ice compresses must not be employed. If we are anxious to do something more, unguentum cinereum with extr. belladonna (1:25) may be applied externally. Under this treatment the inflammatory symptoms disappear in four to five days.

Few patients are able to remain in bed during the inflam-

matory stage of epididymitis, as this is rendered impossible by the necessary secrecy. The application of Horand-Langlebert's suspensory (Fig. 30) then offers an admirable substitute for the, in great part, expectant plan of treatment just described. This consists of a thick layer of cotton, in which the entire scrotum is carefully enclosed; over this comes a piece of rubber cloth suitably cut out, and then a wide linen suspensory, like the ordinary varieties, except that it possesses two lateral gores which are closed by bands. This permits better fitting

FIG. 30.

of the suspensory, especially to the perineum, and enables us to cover the scrotum completely. This apparatus protects the epididymis from external injuries, fixes it and keeps a uniform warm temperature, conditions which correspond to those of rest in bed.

In fact this suspensory has an admirable effect. Patients who could hardly walk on account of the violent pains, experience decided relief immediately after its application and can usually attend to business at once. It is only in cases of considerable swelling of the spermatic cord that the suspen-

sory is not well borne. If it is well borne, it should be worn constantly for several days, the cotton being renewed every twenty-four hours. The bands, which are drawn as tightly as possible during the day, are loosened at night.

Under this plan the inflammatory symptoms also disappear in four or five days, and a second important indication must then be fulfilled, *viz.*, the absorption of the infiltration. Moist heat, and iodine internally and externally, give good results. Those patients who have worn Langlebert's suspensory continue its use, those who have remained in bed wear this or some other wide and comfortable suspensory, which will contain the necessary dressings. We recommend a dressing of moist linen, folded three or four times, over this a piece of parchment or gutta-percha paper, projecting slightly beyond the edges of the linen, and then a tolerably thick layer of cotton. The suspensory is then applied over the cotton. The linen is moistened two or three times a day. If the patient has already worn a Langlebert's suspensory, the form of dressing may be changed as soon as the pain disappears. When the inflammatory symptoms have been treated with cold, it is well to allow an interval of twenty-four hours between the change from cold to warmth, or the change may be made gradually by allowing the cold compresses to remain until they begin to grow warm, as soon as the inflammation subsides. Unless some injury intervenes (coitus, excessive exercise, pollutions, etc.), this treatment causes rapid and thorough removal of the infiltration. If the infiltration is old and firm iodine may be used. The following ointment is rubbed in beneath the damp linen on the diseased side:

℞	Potass. iodid., ...	gr. xxx.
	Iodin. p., ...	gr. iij.
	Lanolin., ...	ʒ v.
	Ol. olivar., ...	ʒ ss.

This is used twice a day, and gr. xv.–xxx. of potassium iodide are given internally *pro die.* Unfortunately this treatment can only be adopted intermittently on account of the eczema which usually develops on the scrotum; when the skin itches and reddens, rice powder must be applied at once. Very old infiltrations and nodules, even if they have lasted for years, usually are absorbed, at least in part, when treated in this way.

Inasmuch as epididymitis is the result of a posterior urethritis, the latter must always be subjected to treatment after the recovery of the former. This may be done even while the painless infiltration is being treated in the manner described above. But the acute inflammatory symptoms must have disappeared for several days, as they are apt to return on premature beginning of treatment.

I can especially recommend Diday's irrigation of the pars posterior as the mildest method.

After the recovery of the epididymitis it is wrong to treat the blenorrhœa, which usually returns, with the gonorrhœal syringe. We have already spoken of its uselessness in posterior urethritis. On the other hand I could never convince myself of the spontaneous recovery of posterior urethritis in these cases, but am satisfied that severe symptoms follow if it is neglected and allowed to pass into the chronic stage.

VI. INFLAMMATION OF THE SEMINAL VESICLES.

Our knowledge of this rare complication of clap is very defective, so that I must content myself with its aphoristic description.

1. Acute spermatocystitis, according to Pitha, usually attacks one, more rarely both seminal vesicles at the same time. Rectal examination shows on the corresponding side of the posterior wall of the bladder, immediately over the prostate, a pear-shaped, firm or fluctuating swelling, which is much larger than the normal seminal vesicle, is painful and warm.

The symptoms consist of dull pressure in the rectum, which radiates towards the sacrum and bladder, and is notably increased on defecation, while micturition is usually undisturbed, though sometimes painful. There is usually violent sexual excitement, manifested by priapistic erections. Pollutions are very frequent, but are accompanied by violent burning pains, especially at the moment of ejaculation, instead of a feeling of pleasure. The ejaculated fluid has a yellow, red or brownish-red color, and leaves stains on the clothing, which are gray in the centre and surrounded by a yellow and brownish-red ring. The microscope shows blood, pus, and either no spermatozoa or dead ones. The patients are usually very depressed or irritable and anxious; this is partly due to the priapistic

painful erections and frequent pollutions. The blenorrhagic discharge either ceases or it is abundant. In the latter event it contains spermatozoa. There may be high fever for a long time. Suppuration of the seminal vesicles, with discharge of the pus into the intestines and recovery, and into the peritoneal cavity with fatal termination, has been observed. On passing into the chronic stage the inflammatory and painful symptoms disappear, but the pollutions may continue, the semen constantly growing thinner and more albuminoid. As in spermatorrhœa, defecation causes the discharge of thick, lumpy, paste-like masses.

2. Chronic spermatocystitis develops in part from the acute form, in part directly as a complication of chronic urethritis.

Its symptoms are very obscure. Humphrey noted violent irritative symptoms on the part of the bladder, and incontinence. In one case I found that both seminal vesicles could be felt *per anum* as firm, indurated, pyriform, painless nodules; despite continence there were extremely few pollutions, the product of which was pus and mucus corpuscles, with a few dead spermatozoa. In another case the very frequent and painless pollutions ejaculated a chocolate-brown mass, the color of which was due to decomposed blood; it contained pus and mucus corpuscles but no spermatozoa.

Post-mortem examinations are very scanty. Gaussaille and Hardy found, in acute vesiculitis, that the seminal vesicles were dilated by a thick, whitish-yellow mass, consisting of semen and pus; the lining membrane of the vesicles was injected, their walls firm. In chronic cases Lallemand and Humphrey found the ducts of the seminal vesicle dilated, the walls thickened, even cartilaginous or bony.

On account of the rarity of the disease the treatment is very meagre. A plan like that adopted in prostatitis may be recommended. In two cases of chronic vesiculitis I have obtained good results from my apparatus, which I mentioned in discussing the treatment of prostatitis, in conjunction with the previously mentioned potassium iodide-iodine suppositories.

VII. INFLAMMATION OF THE BLADDER.

General Remarks.

Cystitis was formerly regarded as one of the most frequent complications of urethral gonorrhœa, and this opinion has been held even in recent times. The latest investigations, however, have materially modified this opinion. The diagnosis of blenorrhagic cystitis is often made at the present time, but usually without justification. Under this diagnosis are usually included three processes, whose accurate differentiation we have learned very recently. These are:

Acute posterior urethritis,—i.e., inflammation of the membranous and prostatic portions, which terminates at the internal prostatic sphincter and leaves the bladder intact.

Cystitis,—either a total or partial inflammation of the vesical mucous membrane; it may be localized in different parts, but is usually situated either at the internal orifice of the urethra or the fundus of the bladder.

Acute posterior urethritis with partial inflammation of the bladder, around the internal orifice of the urethra and at the trigonum Lieulandii.

Pure and uncomplicated posterior urethritis is the most frequent of these three varieties. Next in frequency comes the last-mentioned form, in which the process extends from the pars posterior to the adjoining mucous membrane of the bladder, to the vicinity of the internal orifice of the urethra. This is generally described as "cystite du col," or catarrh of the neck of the bladder, but I would discard the term "neck of the bladder," as it has no anatomical foundation. If by this term we mean only the pars posterior, the expression may be more precise but is superfluous. If the term is also meant to include the adjacent part of the bladder, it becomes vague. In the empty as well as the moderately full condition the bladder really has no neck, and is separated sharply from the urethra by the internal prostatic muscle. It is only in excessive distention of the bladder, *i.e.,* when it is really no longer in a normal condition, that a neck is formed, a reserve reservoir for urine in the posterior portion of the urethra. But this furnishes no reason for an anatomical description of the normal bladder based on a condition which is temporary and

is always associated with discomfort. I will therefore eschew the term neck of the bladder, and propose the term posterior urethro-cystitis for this form of disease. Finally, the rarest cases are those of pure cystitis. It usually develops from a posterior urethro-cystitis, very rarely directly, inasmuch as the initial symptoms of posterior urethritis disappear rapidly or are barely marked.

With regard to the etiology of the cystitis, it is questionable whether it constitutes a direct blenorrhagic affection or is to be regarded as a mixed infection, due to the intervention of other irritants. Bumm maintains that every cystitis in the female is produced by a mixed infection, and this is also very plausible with regard to males. The urine of the bladder, in every case of cystitis, contains numbers of cocci and bacteria, while a large number of gonococci, from which we might infer proliferation in the bladder, cannot be demonstrated. The gonococci, if present at all, are always found in small numbers.

Symptomatology.

Posterior Urethro-cystitis.—The symptoms are a mixture of those of posterior urethritis and cystitis. As a rule, the subjective symptoms are due to the former, while the latter is manifested by objective symptoms alone. With regard to the subjective symptoms I may refer to the article on posterior urethritis. There is usually tenesmus, almost constant in acute cases, while in subacute cases it is only imperative when the bladder is full. In addition there are radiating pains along the urethra, burning and tenesmus after micturition. In the subacute cases is also found another symptom to which I was the first (1880) to call attention. This is the variation in the tenesmus according to the position of the patient. So long as he stands and walks the tenesmus is more frequent and imperative than when the recumbent position is assumed. In the erect position the urine accumulates upon the inflamed portions of the vesical orifice and surrounding parts, which it irritates by its weight and thus increases the tenesmus, while in the recumbent position the bladder sinks down and the urine is received in the fundus.

Among the objective symptoms the discharge of blood with the last drops of urine is dependent on the acute posterior urethritis.

In the test of the two beakers the urine is found cloudy in both. But there are some material differences from simple posterior urethritis. In acute posterior urethritis the second urine, although cloudy, is always clearer than the first, and second clear portions alternate with cloudy ones. We have already explained the reason of this phenomenon.

In acute posterior urethro-cystitis the cloudiness of the urine in the bladder is the result of two factors, *viz.*, the muco-pus which enters the bladder from the pars posterior, and then the muco-pus which is formed in the bladder by the catarrhal mucous membrane. It therefore follows that:

Inasmuch as the cloudiness is produced in the bladder itself, a second clear urine is never observed.

In posterior urethritis the cloudiness of the first urine is caused by the pus in the urethra, while the second urine is cloudy from the excess of pus which has passed from the pars posterior into the bladder. In urethro-cystitis the urine is clouded in the bladder by the pus and mucus produced there. In the latter disease, therefore, the cloudiness of the urine in both vessels is more pronounced, the difference between both portions is not considerable, because the muco-pus will be precipitated in the bladder and will escape with the last urine.

If a patient with acute posterior urethro-cystitis is allowed to urinate in three portions, the first will be very cloudy from the excess of muco-pus in the urethra; the second is less cloudy, containing the upper layers of urine from the bladder which flow through a clean urethra; the third portion is again more cloudy, because it washes away the muco-pus produced in the bladder and which has been partly precipitated. Some patients notice that with or after the last drops of urine pure pus escapes from the urethra in a few drops or a short stream.

If this urine is allowed to precipitate in two or three portions, we usually find the two well-known layers, a lower, rapidly precipitating, crumbly layer of pus: an upper, loose, slowly precipitating, cloudy or flocculent layer of mucus; above this clear urine. The relative proportions of both layers vary, whence we may distinguish a more mucous or more purulent catarrh.

The microscopical examination shows pus and mucus corpuscles, large flat epithelium of the bladder, and variously formed epithelial cells, which are derived partly from the lower

layers of the bladder, partly from the urethra. In the first urine we often find quite numerous gonococci in the pus cells; in the second urine pus cells containing gonococci are scanty or absent, while there is often an abundance of other cocci and many short rods, not in cells.

Chemical examination constantly shows a small amount of albumin; when the tenesmus is violent it often persists as long as the latter, may become very considerable, and is produced by the tenesmus.

The reaction of the urine is usually acid, rarely alkaline. The latter reaction is generally due to hæmaturia. If the posterior urethritis is very acute, blood not alone appears with the last drops of urine, but the hemorrhage from the pars posterior, excited by the violent tenesmus, is abundant and protracted. The blood which escapes from the pars posterior in the intervals between micturition, enters the bladder and may neutralize the acid reaction of the urine accumulated there or make it alkaline.

In making the test of the three beakers the urine is then found bloody in all. In the third glass, the muco-pus, mixed with blood, appears as a tough, snotty mass which adheres to the vessel, and under the microscope shows variously shaped, in part destroyed, blood and pus corpuscles, epithelium and the well-known coffin-lid triple phosphate crystals. The urine is foul smelling and filled with micro-organisms. The amount of albumin is large, probably dependent on the presence of blood.

It is hardly to be supposed that in these cases the inflammation of the bladder is confined to the vicinity of the vesical orifice, but it probably affects the entire mucous membrane. In addition to the symptoms mentioned there is often violent pain over the symphysis, which increases on pressure, and slight paresis of the detrusors. The bladder, despite frequent micturition, remains half filled and can be felt above the symphysis. If the acute posterior urethritis subsides, the tenesmus and hæmaturia disappear, while the symptoms of acute purulent cystitis remain and not infrequently become chronic.

Acute Cystitis.—This is a rare complication of acute urethritis. It very rarely happens that an acute anterior urethritis extends unnoticed to the pars posterior and then gives rise to cystitis. The acuteness of the inflammatory symptoms on the

part of the pars posterior almost always provokes, in such cases, an acute posterior urethro-cystitis. More frequent are cystitides resulting from subacute and chronic posterior urethritis, which extends to the bladder as the result of the well-known local or remote irritants. Cystitis also develops as the residuum of an acute urethro-cystitis when the symptoms of acute posterior urethritis have disappeared. In these cases the acute cystitis usually produces few subjective symptoms. General malaise, the result of slight fever, pain over the symphysis and moderate tenesmus are the only symptoms.

The test of the two or three beakers always shows most marked cloudiness of the second or third vessel, because this depends on the muco-pus produced in the bladder and which has been, in part, precipitated.

We may distinguish two grades of this disease:

Mucous, Catarrhal Cystitis.—The urine is acid, slightly cloudy, precipitates slowly. The sediment is flocculent, consists of numerous mucus corpuscles, large bladder epithelium and micro-organisms.

Purulent Cystitis.—The cloudiness of the urine is more marked, its reaction neutral or more frequently alkaline. The sediment is white and crumbly, and precipitates rapidly; or, if the reaction is alkaline, it is snotty and lumpy, yellow or greenish. The microscope shows numerous pus corpuscles and, if the reaction is alkaline, abundant coffin-lid crystals of the triple phophates. Numerous micro-organisms and bladder epithelium are always found. When the reaction is alkaline the urine is always very foul smelling. The amount of albumin is proportionate to that of pus.

Chronic Cystitis.—This develops very rarely directly from chronic posterior urethritis and prostatitis, more often it develops from acute cystitis. Here also we may distinguish mucous and purulent catarrh. The objective symptoms just mentioned become permanent and often contrast in a very striking manner with the absence of all subjective symptoms.

The causes of the spread of the inflammation to the bladder are the well-known intercurrent morbific agents which operate during the course of urethritis. Some of these are particularly adapted to the production of cystitis. Thus, excesses in venere or Baccho, during the course of acute posterior urethritis, give rise much more often, indeed almost without exception, to epi-

didymitis. The development of urethro-cystitis or cystitis, on the other hand, is usually the result of direct local irritation, instrumental examination or strong injections. This fact favors the view that cystitis is the result of other irritants which have been introduced in this way, as was directly observed in Paillard's previously mentioned case.

As a rule, acute anterior urethritis is first followed by a posterior urethritis, and this by cystitis, or the anterior urethritis is followed directly by posterior urethro-cystitis, which remains in an acute or subacute stage for a few days, and then generally disappears rapidly.

But the symptoms of urethritis may disappear first, those of cystitis then predominate for some time, and finally these also recover. Finally, the cystitis may pass into a chronic stage. These are the most frequent terminations. A rarely observed termination is that of the spread of the inflammation to the other layers of the bladder, and the development of parenchymatous cystitis. This is always a dangerous disease. Ulceration of the bladder and perforation, with fatal peritonitis, may set in, as in Gintrac's case. The inflammation may also spread outwards layer by layer without ulceration, extend to the peritoneum and be followed by purulent peritonitis and death, as in Gendrin's previously quoted case.

Finally, another rare eventuality is the extension of the inflammatory process to the renal pelvis and the kidney.

Diagnosis and Differential Diagnosis.

The diagnosis of posterior urethro-cystitis, acute and chronic cystitis, is evident from the symptomatology just described. Acute posterior urethritis must be differentiated from posterior urethro-cystitis and acute cystitis. A consideration of their individual symptoms, especially testing the urine in two or, if necessary, three vessels will usually enable us to make the diagnosis without difficulty. Nevertheless there are cases, generally of a subacute character, in which in addition to the symptoms of subacute posterior urethritis, there is uniform cloudiness of the urine in both vessels or even in all three, and it is not easily settled whether we have to deal with a pure posterior urethritis or an urethro-cystitis. If other methods of examination have given no sufficiently de-

cided result, the following plan is recommended. A narrow elastic catheter is introduced into the bladder, the organ washed out with lukewarm water, and the catheter, which is kept closed, allowed to remain. At the end of an hour the urine accumulated in the bladder is discharged through the catheter. If this urine is clear the implication of the bladder in the inflammatory process is excluded.

I must also make mention of phosphaturia, which, to the superficial observer, presents a picture similar to that of cystitis. The fact that both processes are often confounded proves the routine manner of ordinary examinations, and that the diagnosis of cystitis is often made from mere cloudiness of the second urine. In order to avoid error we recommend Ultzmann's simple method, which is easily made at each examination. A test tube of the cloudy urine is slowly heated to the boiling point. If the cloudiness disappears, it consists of urates. If it becomes more pronounced, a few drops of acetic acid are added. If it then disappears, it consists of earthy phosphates; if unchanged, it is due to pus. Finally, if the cloudiness remains unchanged on boiling and the addition of acetic acid, it is composed of pus or bacteria, and the distinction is shown under the microscope.

Pathological Anatomy.

The number of autopsies on blenorrhagic cystitis is small. The few known ones, such as those of Gendrin and Gintrac, disclosed very marked changes, which are not found in the majority of cases. Thus, in Gendrin's case, the bladder was smaller than normal, its walls rigid and thickened, its contents sanguino-purulent. The mucous membrane, considerably thickened, was covered with a thick layer of tough muco-pus, and showed several ulcerations of different sizes. The peritoneum, especially at the fundus of the bladder, had a wine-red color and was covered with firmly adherent membranes. In Murchinson's case the mucous membrane of the bladder was thickened, reddened and covered with pus.

Examination of the bladder with the endoscope, which I adopted in 1879 in association with Nitze, furnishes us clear data concerning the ordinary changes in the mild and more frequent cases. According to the severity and extent of the

process the bladder is found more or less ridged *in toto* or in places, more or less reddened or traversed by dendritic vessels. The epithelium is lifted from its base, and loosened in shreds, which in part are still adherent to the mucous membrane by thin threads, in part float free in the urine, while the swollen follicles project as dark red points.

Prognosis.

As in all complications of blenorrhœa the prognosis should not be made absolutely favorable. In the first place, cases have been known, though rarely, to have a bad or even fatal termination, and, in the second place, all complications, including cystitis, have a tendency to pass into an obstinate chronic stage. Nor must it be forgotten that a complication creates a striking predisposition to its redevelopment on fresh infection, and that the obstinacy of the affection always increases on its recurrence.

Treatment.

The indications for treatment vary according to the intensity and acuteness of the process. In acute urethro-cystitis and cystitis the treatment is chiefly symptomatic and expectant. Regulation of hygienic and dietetic measures often suffices to effect rapid recovery of the affection. Above all rest in bed is necessary, and the patients readily yield to this instruction, inasmuch as cystitis is always regarded by them as a dangerous disease. In addition we order fever diet, and regulate the bowels. The following decoctions are ordered as drinks:

℞ Decoct. fol. uvæ ursi, ... ℥ xvj.
Syr. diacodi., ... ℥ ss.
S. One tablespoonful every two hours.

℞ Decoct. semin. lini., ... ℥ xvj.
Tinct. opii, ... gtt. xv.
Aq. laurocerasi, ... ʒ iiss.
S. One tablespoonful every hour.

℞ Herb. herniariæ,
Fol. uvæ ursi, ... āā ℥ j.
S. Made into a tea. One cupful morning and evening.

℞ Herb. herniar.,
Herb. chenopod. ambros., . . . āā ℥ j.
S. To be made into a tea.

If the hæmaturia is marked, styptics are given internally, for example:

℞ Ferri sesquichlorid. sol., ... gtt. xv.
Aq. destil., ... ℥ v.
Syr. amant. cort., ... ʒ vj.
S. One tablespoonful every hour.

Painful symptoms are treated with suppositories of extract of belladonna and morphine, or subcutaneous injections of morphine. Opium is to be avoided, as it is apt to produce constipation. Warm abdominal compresses are the simplest remedy in pain, tenesmus and dysuria; when these are more severe, morphine is indicated.

Causal treatment is only adopted after all irritative symptoms have disappeared and the objective symptoms still continue.

This treatment must first be internal.

The well-known balsams (oil of sandal wood, copaiba, turpentine), prescribed as in urethritis, often produce good effects and cause the urine to clear up rapidly. If they are not well tolerated or do not produce the desired effect, we may prescribe:

℞ Tannin, ... gr. xv.
Camphor ras., ... gr. iss.
Sacch. alb., ... ʒ ss.
Inf. pulv. Div. in dos. X.
S. Three powders daily.

℞ Extr. cannabis ind.,
Extr. hyoscyami, ... āā gr. v.
Sacch. alb. . . . . gr. lxxv.
M. f. pulv. Div. in dos. X.
S. Three to five powders daily.

℞ Acid benzoic, ... gr. lxxv.
Aq. destil., ... ℥ x.
Syr. cort. amant., ... ʒ vj.
S. One tablespoonful every two hours.

℞ Extr. cannabis ind., ... gr. v.
Sacch. alb., ... gr. lxxv.
M. f. pulv. Div. in dos. X.
S. Three to five powders daily.

℞ Soda salicyl., ... ʒ iiss.
M. f. pulv. Div. in dos. X.
S. Three powders daily (in wafers).

℞ Potass. chlorat., ... gr. xlv.–lxxv.
Aq. laurocer., ... ʒ ss.
Aq. destil., ... ℥ x.
S. To be taken in one day (caution!)

Alkaline waters are to be used cautiously. So long as the affection is a mild, mucous, catarrhal process, and the urine is distinctly acid, the waters of Preblau, Giesshuebl, Gleichenberg, and Wildemgen often have rapid and good effects. But if the urine is feebly acid or alkaline, and there is a tendency to phosphaturia, these waters are directly contra-indicated. They increase the alkalinity of the urine and the phosphaturia and keep up the process, while it should always be our object to increase the acidity of the urine. The above-mentioned remedies, the balsams, tannin, salicylate of soda and benzoic acid are especially adapted to this purpose. But it often happens that, although the irritative symptoms disappear, these internal remedies do not prove successful. The urine remains cloudy and continues to contain pus and mucus. Local treatment is indicated in these cases. In addition to or apart from the internal treatment, we proceed to wash out the bladder with medicated solutions. These irrigations are best performed by first introducing an elastic, not too large catheter, into the moderately full bladder and evacuating the urine. We next inject, by means of a syringe, containing 6 to 10 ounces, one or two syringefuls of lukewarm water into the bladder, allow it to escape at once, and then one of the following solutions, after it has been warmed:

℞ Acid salicylic, ... gr. xv.
Aq. destil., ... ℥ vj.

℞ Resorcin, ... gr. xlv.–lxxv.
Aq. destil., ... ℥ iij.

℞	Quininæ sulph., ...	gr. vij.
	Aq. destil., ...	℥ xij.
℞	Potass. hypermang., ...	gr. iss.
	Aq. destil., ...	℥ vj.
℞	Acid boric, ...	gr. xlv.
	Aq. destil., ...	℥ vj.
℞	Argent. nitric, ...	gr. vij.–xv.
	Aq. destil., ...	℥ xv.

These solutions are allowed to remain in the bladder for three to five minutes, then removed and water injected, unless we prefer to allow the solution to remain in the organ.

In chronic cystitis tonic regimen is indicated, in addition to local and internal treatment. Many chronic cystitides, kept up by nutritive disturbances or cachexia, are only cured after recovery of the latter.

VIII. INFLAMMATION OF THE RENAL PELVIS AND KIDNEY.

This rare complication of acute urethritis is also the least known. The diagnosis of blenorrhagic pyelitis is made not infrequently, but usually improperly. If a patient with acute blenorrhœa suffers, in addition to violent tenesmus and the symptoms of acute urethro-cystitis, from pain in one or both loins, fever and perhaps chilliness, if the examination of the urine shows a larger amount of albumin than is accounted for by the amount of pus, pyelitis is commonly diagnosed. This diagnosis is erroneous. In cases of violent tenesmus the large amount of albumin results from this symptom, as can be very easily proven. If the tenesmus is ameliorated the amount of albumin diminishes at once and corresponds to the amount of pus, and increases at once with the increase in the tenesmus.

We must reserve the diagnosis for those cases in which the amount of albumin is larger than that of pus, apart from the tenesmus, and the microscope shows casts and epithelium of the straight urinary tubules in the sediment. Such cases occur and have been reported by Vidal, Rosenstein, Zeissl and myself. Murchinson performed an autopsy on a case of suppurative pyelo-nephritis, but these cases are so rare and their origin so obscure, that I must confine myself to these brief remarks.

CHAPTER V.

BLENORRHŒA IN THE FEMALE.

General Remarks.

Less known and studied than blenorrhœa in the male is the analogous disease in the female. Although due to the same etiological factor, the conveyance of blenorrhagic, gonococci-containing pus, the symptoms are not so typical and pronounced as in man. It is manifested by catarrhal suppuration of the mucous membrane of the uro-poetic system, which may run an acute course or pass into a chronic stage, may extend to the connected mucous surfaces, and to the glandular organs of the uro-genital tract. But there is one essential difference between blenorrhœa in the female and in the male. In the latter the catarrhal processes of the urogenital system are produced, almost without exception, by blenorrhœa, so that if we observe a purulent secretion from the urethra, an acute prostatitis or epididymitis, we have considerable justification *à priori* to infer its blenorrhagic character. In the female this is entirely different. General diseases, disturbances in the physiological functions of menstruation and pregnancy, are the cause, or at least part cause of catarrhal affections of the genital organs, which are followed not infrequently by disease of the uro-poetic system. Some of these conditions also give rise to diseases of the annex organs, the uterus and surrounding parts, ovaries, etc. In the female, therefore, blenorrhœa does not have such a sovereign influence in the etiology of diseases of the uro-genital tract as in the male.

We might point to the importance of the gonococcus in diagnosis and therefore in the study of blenorrhagic affections. But even in this respect the conditions are much more complicated. We know that the gonococcus is particularly abundant in the acute stage of blenorrhœa, while its discovery is uncertain and difficult in chronic blenorrhœa. Blenorrhœa in the

female, unlike that in the male, is characterized by the fact that it possesses a much more marked tendency to run rapidly through the acute stage and to pass into a chronic stage. In addition, the discovery of gonococci on the mucous surfaces accessible to examination is interfered with by the fact that they form the soil for a series of micro-organisms to a much greater extent than in man, and thus interfere materially with the recognition of the gonococcus as such.

Another circumstance must be considered. The mild course of the blenorrhagic disease, *i.e.*, the slight acuteness of the symptoms, but especially the feeling of modesty which is pronounced even in the lowest classes among women, constitute the motives for concealing genital affections as long as possible. And thus the acute stages of blenorrhœa of the female sexual organs often escape the notice of the physician, and only the later and graver consequences, which no longer bear the stamp of the disease, come under observation. Hence this disease in the female is often overlooked, unrecognized, and insufficiently studied.

Corresponding to the complete division of the sexual and uro-poetic system in the female, we will consider urethritis and vaginitis as the primary blenorrhagic diseases. These are followed by a series of complications which will be discussed later.

I. URETHRITIS.

General Remarks.

The statements concerning the frequency of this disease differ in a very striking manner. Swediaur states that he never observed a case of urethritis in the female. Ricord says that in contagious blenorrhœa of the female the urethra is often affected alone, or at least participates in the disease of the other mucous membranes. The recent writers agree almost unanimously concerning the frequency of blenorrhagic urethritis, and that it is never absent in cases of recent infection. Zeissl alone maintains that there are only 5 cases of urethral blenorrhœa among 100 cases of blenorrhagic vaginitis. This striking difference of opinion is owing to the rapid and mild course of the acute stage, and to the readiness with which chronic urethritis in the female is overlooked. Cheron

states that in the female there is one acute urethritis to five chronic urethritides.

SYMPTOMATOLOGY.

Thanks to the short and straight course of the female urethra, its simple structure, the absence of large glands, female urethritis is a milder affection than in the male.

After a period of incubation, which Martineau estimates at two to five days, the urethritis begins, in acute cases and in sensitive women, with slight chilliness, which appears only on one or two evenings, and slight malaise. At the same time the patients complain of mild burning and tickling on micturition; in some cases this is quite annoying for several days. These are the only perceptible symptoms, but not infrequently subjective symptoms are entirely absent, or there is slight burning during micturition which is ignored or overlooked.

On examination of the patient, who should not have urinated for several hours, the orifice of the urethra will be found swollen and reddened, the urethral mucous membrane intensely reddened and perhaps somewhat prolapsed. On passing the finger into the vagina the urethra is felt as a firm cord which is tender on pressure. On pressing from behind forwards along its course often quite large drops of creamy pus escape from the orifice. On microscopical examination this shows the same elements as in man, especially numerous gonococci in the pus cells.

If the patient urinates into two vessels, we will find cloudy urine in the first, clear urine in the second vessel. Cloudiness of the second urine indicates coincident cystitis. There is no division of the urethra into two parts as in man. The female bladder possesses a true sphincter, which consists of smooth and striped muscular fibres, and forms a sharp boundary between the urethra and bladder. There is no neck of the bladder in the female, in the sense of a part which belongs at times to the urethra, at times to the bladder. However full the female bladder—and, as is well known, its capacity is greater than in the male—all the urine remains in the organ, the urethra always forms a short canal, which is open anteriorly, firmly closed towards the bladder, so that regurgitation of pus from the urethra into the bladder is impossible.

The few subjective symptoms which constitute the acute

stage have usually disappeared in three weeks, at the furthest, and the patients, and indeed many physicians, then regard the blenorrhœa as cured.

But this is not true. Female urethritis passes into a chronic stage much more often than has been hitherto believed. This, while not so serious, so far as our imperfect knowledge goes, as chronic blenorrhœa in the male, nevertheless presents sufficient danger. In the first place it may exacerbate after external irritants, as in the male. The patient not alone suffers from a contagious disease, or, at least, one which often becomes so at each relapse, but it may extend beyond its original boundaries and give rise to the symptoms of temporary urethro-cystitis, which is similar to that in the male, buts runs a milder and more rapid course.

The symptoms of chronic urethritis in the female are exclusively objective. They are found on careful examination of the urethra after the patient has not urinated for several hours. Pressure on the urethra, from behind forwards, usually forces out a drop of thin, milky muco-pus. If the patient is allowed to urinate, after the vulva has been carefully cleansed of mucus, we find either slight cloudiness of the urine or clap shreds, as in the male.

The female urethra is rich in follicles, which are situated along the entire mucous membrane as well as at the orifice. These follicles may take part in the blenorrhagic process. They become swollen and sensitive and form small nodules, which disappear or enlarge and open into the urethra without being attended by further consequences.

Disease of the follicles at the orifice, which are usually situated on both sides and below the meatus in small funnel-shaped fissures, often runs a slow course. In examining a woman with blenorrhœa, pressure on the orifice extrudes pus, which is supposed to come from the urethra. But if the patient is allowed to urinate previously, *i.e.*, if the urethra is cleansed, and the parts are carefully inspected during the examination, we can convince ourselves that the pus appears in the fissures at the sides of the urethra. If the follicles had been previously squeezed and the pus removed, and if the urethra is then examined from behind forwards, or if the patient is allowed to urinate, we can also demonstrate the presence of chronic urethritis.

Blenorrhagic inflammation of the follicles at the orifice is either chronic, *i.e.*, a small quantity of pus is secreted without any symptoms, or it is acute and relapsing. One or another of the follicles enlarges, the meatus becomes unsymmetrical, the mucous membrane over the follicle is reddened. A small point of pus soon appears, an abscess forms in the follicle, rapidly opens and discharges, and closes with equal rapidity. In a short time this process is repeated in the same or another follicle, and this may continue for a long time. Slight pain on palpation is the only symptom of this affection, which is usually unnoticed by the patient. Guérin called it external urethritis, and proved its blenorrhagic character and contagiousness by some accurate observations. Small, insignificant fistulæ may result from the rupture of the abscess into the urethra and vulva at the same time.

Pathological Anatomy.

The anatomy of the disease has been little studied. In a patient who died of typhoid fever, Mercier describes the mucous membrane of the blenorrhagic urethra as uniformly red in the lower part, the remainder was injected in patches.

In a servant who died of cysto-pyelitis and nephritis, Murchinson found both kidneys in a condition of acute nephritis, the renal pelves and ureters filled with pus, the bladder distended with purulent urine, its mucous membrane, like that of the urethra and vagina, intensely reddened.

Examination with the endoscope in the acute stage usually shows uniform redness, swelling, and velvety loosening of the mucous membrane. In chronic cases the mucous membrane is reddened in patches and stripes, or the redness, associated with slight erosion, merely surrounds the openings of a few, usually prominent, follicles. I never found granulations, but the number of cases which I had the opportunity to examine was small.

Diagnosis and Prognosis.

The diagnosis is evident from the symptoms just described. Attention must be paid particularly to the origin of the pus, whether it comes from the urethra or the follicles of the meatus. In chronic urethritis frequent examination is necessary, especially after the patient has not urinated for some hours.

In otherwise negative cases, a decision is arrived at from examination of the urine after its retention for several hours and after careful cleansing of the vulva. This is always annoying, and often impracticable for external reasons.

The prognosis of urethritis in the female is always more favorable than the corresponding affection in the male. Chronic urethritis is much more amenable to treatment, the conditions for recovery are more favorable. Unfortunately the latter affection often escapes our observation and treatment.

Treatment.

In the acute stage the treatment is hygienic and symptomatic. The regimen, as regards exercise, food and drink, is the same as in the male.

If the subjective symptoms have disappeared but suppuration persists, balsams internally, and local injections of hypermanganate of potash and sulphate of zinc, are indicated. The injections are made, when the bladder is moderately full, with the ordinary clap syringe half filled. The bladder should always contain urine in order to prevent direct action of the injection fluid upon the wall of the bladder, provided it enters the bladder, which is more apt to occur on account of its anatomical structure.

The torpidity of female urethritis soon permits active local treatment, particularly the application of tincture of iodine or a solution of nitrate of silver (2 to 5 per cent.) through a short endoscope or by means of little tampon brushes (smooth narrow strips of wood covered with cotton).

Folliculitis of the urethral meatus is an obstinate affection, which is only cured by destruction of the follicles. This is done with a narrow stick of lunar caustic, or, better still, with the fine point of a Paquelin cautery.

II. VAGINITIS.

General Remarks.

Vaginitis occupies the most peculiar position among the more common blenorrhagic affections. Originally regarded as the most frequent form and the prototype of female sexual blenorrhœa, its blenorrhagic character is now denied by many.

Bumm endeavored to show by a series of careful investigations that a proliferation of gonococci in the vagina and their entrance into its epithelium does not take place. He claimed that the site of blenorrhœa in these cases is the cervical canal or uterine cavity, and the pus produced in these parts, and which contains gonococci in abundance, flows into the vagina. Here it irritates and macerates the vagina and causes inflammation of its surface, just as blenorrhagic secretion entering the preputial sac produces balanitis, which is not regarded as blenorrhœa. The pus from the cervix mingles with the secretion of the vagina and therefore contains gonococci, but the vaginitis itself is catarrhal, *i.e.*, it results from simple irritation and is not a blenorrhagic affection.

Bumm attempted to prove this view in various ways. In the first place he claims that, according to his microscopical examinations, gonococci only enter cylindrical epithelium, that they cannot pass through pavement epithelium, and whenever cylindrical and pavement epithelium come in contact, the gonococci disappear where the latter begins. The vagina is covered with firm pavement epithelium, which resists the entrance of gonococci.

Bumm also examined portions of the inflamed mucous membrane of the vagina, and never discovered gonococci therein.

Finally, he kept blenorrhagic secretion in direct contact with the vaginal mucous membrane for twelve hours and could never produce vaginitis in this way. The vagina also remains normal, despite the most severe, cocci-containing cervical or uterine blenorrhœa, which permits the abundant secretion to flow into the vagina, provided the irritant action of this secretion is prevented by securing its thorough removal. On the other hand, the delicate epithelial lining of the youthful vagina was not absolutely proof against the invasion of gonococci, but the symptoms ran a much more mild and rapid course.

That there is a vaginitis which is associated with blenorrhœa of the urethra and of the cervix and uterus, cannot be denied. But according to these views of Bumm and the more recent investigations of Steinschneider, the cervical or uterine blennorrhœa is produced by the primary infection, and the secretion stagnates in the vaginal canal and produces vagini-

tis. In accordance with this notion, cervical or uterine blenorrhœa must be present in every case of vaginitis, a point concerning which our present statistics are silent, but which Schwarz, as the result of his examinations, denies. That vaginitis may communicate blenorrhœa would be explained by the fact that, together with the secretion of the cervical canal, it also contains its gonococci, which proliferate in the vaginal secretion as in an incubator, and may even cover the vaginal epithelium, but do not penetrate it. In addition to the gonococci a considerable number of other cocci and bacteria also find favorable conditions for proliferation in the vaginal secretion.

These views, which are opposed by Schwarz in every detail, are not sufficiently proven, however probable they may appear. The demonstration of cases of vaginitis, without coincident cervical and uterine blenorrhœa but containing gonococci, would disprove this view and demonstrate the possibility of the hitherto assumed primary blenorrhœa of the vagina. Until this question is definitely decided I prefer to leave vaginal blenorrhœa in its former position as a primary blenorrhœa, and to await the results of further investigations.

Symptomatology.

Like other blenorrhagic affections in the female, vaginitis possesses the peculiarity of running quite rapidly through the acute stage, soon passing into a chronic stage, and of presenting relatively few symptoms during the acute period.

The following are the symptoms of acute vaginitis: In the beginning the patients experience a feeling of weight, dragging and burning in the genitalia, and there is increased secretion, at first mucous, then purulent, which stiffens the clothing, and has a yellowish color. The pains increase and radiate towards the pelvis and thighs; they increase on movement and defecation, and not infrequently compel sensitive women to take to bed. Slight chilliness and a feeling of dullness and fatigue are added, the secretion increases, and, by its irritation, causes more or less marked vulvitis, and also gives rise to intertrigo and eczema by flowing into the inguinal folds and upon the perineum and thighs.

In addition to the urethritis and vulvitis which are usually

present, examination shows swelling of the introitus vaginæ. The fimbria and caruncles are swollen, their mucous membrane reddened and eroded; the swollen follicles are shown by punctate, dark, often elevated and intensely reddened spots. A considerable amount of creamy pus, which is neither viscid nor gelatinous, wells up out of the introitus, especially on pressure upon the perineum. On passing the finger into the vagina considerable elevation of temperature is felt, and the mucous membrane is also felt to be more rigid, its folds more prominent. In many cases the entrance of the well-oiled finger is impossible, the pain produced thereby so violent that spasm of the sphincter vaginæ (vaginismus) sets in.

As a matter of course examination with the speculum is impossible in these cases. In others this can be done, and the following changes are noticed after the pus has been wiped off: In places the epithelium seems to be lost, and superficial, easily-bleeding erosions are formed. In some cases, usually not the most acute ones, the markedly infiltrated folds appear to be covered by deep red granules, which are quite uniform and may attain the size of a hemp seed. The entire vagina then appears granular, a condition known as psorélytrie, vaginitis granulosa or papillaris. This form is especially frequent in gravid females. Martineau states that he found it particularly in scrofulous and cachectic individuals.

The mucous membrane of the portio vaginalis is also swollen, its follicles more prominent. Superficial erosions, perhaps as large as a pea, are also found, particularly on the lower lip. In many cases—whether it is true of all I am unable to say—the orifice of the cervical canal is reddened, partly eroded, gaping, and from it escapes a tough purulent plug.

The course of the acute blenorrhœa is quite typical. The symptoms attain their height in eight to ten days and then slowly diminish, so that the vaginitis is usually cured in three to four weeks. But relapses are not rare. These occur in part after external noxious influences, but particularly after menstruation, which is always followed, even if the process is entirely healed, by a short stage of subacute vaginitis with increased secretion and redness of the mucous membrane.

Chronic vaginitis, which is a sequel of acute vaginitis that is maintained by local irritation or by frequent relapses, is either diffused over the entire mucous membrane, or localized.

In both cases subjective symptoms are absent; in the former the secretion is still considerable, in the latter it is not notably increased. In diffuse vaginitis examination with the speculum shows thickening of the mucous membrane, whose folds are very prominent and covered with granulations; the color is partly red, partly even livid; erosions are found particularly in the fornix and on the portio vaginalis.

In the localized cases, one or more patches of reddened, partly eroded and swollen mucous membrane are seen in the deeper portions of the vagina, particularly in the posterior fornix.

Chronic vaginitis terminates in a change which is found with special frequency in prostitutes. This is a form of fibrous degeneration known as xerosis vaginæ. The mucous membrane becomes rigid and thick, it dries from destruction of the follicles, the epithelium is thick and white, like chronic stomatitis, with psoriasis mucosæ, and the condition incurable.

Diagnosis and Prognosis.

The diagnosis may be made from the symptoms mentioned. The proof of its blenorrhagic character is obtained from the presence of co-existing blenorrhagic affections and the demonstration of gonococci.

With regard to the former, the urethra must first be examined. Acute or chronic urethritis, the demonstration of suppuration, with or without inflammatory symptoms, from the urethra or the follicles around its orifice, and the discovery of gonococci, which is hardly ever attended with difficulty, are important diagnostic indications.

The discovery of gonococci in the vaginal secretion itself is more difficult. In the first place it contains a large number of other micro-organisms which interfere with the recognition of the gonococci. Indeed, Lomer states that the vaginal secretion is unsuited to the demonstration of gonococci. Bumm also attaches little importance to examination of the vaginal secretion, in which, according to his belief, gonococci occur only secondarily. Schwarz, on the other hand, maintains the existence of a primary vaginal blenorrhœa, and discovered gonococci in the vaginal mucous membrane, after irrigating the canal freely and removing the secretion and micro-organ-

isms. After the irritating irrigation a reaction develops in the vaginal mucous membrane in the shape of active cell proliferation, which brings the gonococci, intra-cellular and free, to the surface. If some secretion is now scraped with the knife or curette from the mucous membrane, we can, as a rule, discover the gonococci.

The prognosis must be made with great caution. Vaginitis itself is often cured with great difficulty, and especial consideration must be paid to the fact that an extension of the process to the uterus may give rise to the most serious, even incurable complications, which may seriously endanger not only health but even life.

Treatment.

Acute vaginitis not infrequently runs its course spontaneously, if cleanliness and removal of the secretion are attended to. The subacute and chronic forms are much more obstinate. Hence the treatment of acute vaginitis is expectant and mildly astringent, that of chronic vaginitis is strongly astringent, even caustic.

In the first and most severe stage of acute vaginitis treatment is usually impossible on account of the violent pains which characterize the affection. It is then our object to secure a rapid termination of the acute stage, by rest in bed, regulation of the bowels, cool sitz-baths, cold compresses on the genitalia and perineum, mild and unirritating diet. Potassium bromide, chloral hydrate and morphine relieve the nervous excitement which is so frequent at this period.

When the acute symptoms have subsided so that instruments may be introduced into the vagina, we resort to local treatment, consisting in the application of astringents and the removal of the accumulated secretion.

Treatment which is carried out under the control of the eye is always the most effective. It is therefore best to introduce a speculum, carefully cleanse the vaginal mucous membrane with tampon brushes and then to apply the astringent to the vagina by means of these brushes or by irrigation. We prefer 1 to 2 per cent. solutions of permanganate of potash. Applications of a 1 per cent. solution of nitrate of silver may be used, in addition, every two or three days, if the symptoms

are subacute, especially in vaginitis granulosa. After each cauterization or irrigation the vagina is filled with cotton tampons, which are fastened to one another with thread and introduced through the speculum.

This method of treatment, which is entirely in the hands of the physician or a midwife, is usually impracticable, except in a hospital service. And so the treatment must often be carried out by the patient. In such cases it is best to use an irrigator, to the rubber tube of which is attached a vaginal tip, a slightly curved hollow bulb, whose tip is perforated like a sieve. For irrigation we order 1 per cent. solutions of permanganate of potash, chlorate of potash, sulphate of zinc, or a 2 per cent. solution of alum, the vagina being irrigated three times a day with about 2 quarts of the slightly warmed solution. The part which first enters the vagina coagulates the secretion and removes it in shreds, the remaining fluid comes in direct contact with the vaginal walls. Tamponing of the vagina must usually be abandoned in these cases, as the tampons recommended are not suitable. The physician should examine with the speculum every three or four days, and may then make applications of 1 per cent. solution of nitrate of silver, tincture of iodine or liquor ferri sesquichlorati. These remedies, applied every third day, are to be recommended particularly in subacute cases.

In obstinate subacute vaginitis the astringents mentioned should be applied daily for several successive days. The vagina is brushed and tamponed. On the following day the tampon is removed, the mucous membrane cleaned and again brushed. If this is repeated for several days, the mucous membrane begins to exfoliate in shreds. The brushings are then discontinued, but the above-mentioned irrigations are employed daily until the mucous membrane is regenerated; if it has not regained the normal appearance, the procedure is again begun. Alum, which is dusted on tampons or sewed up in bags of mull, acts very vigorously in this way. A mixture of powdered sulphate of copper and alum (10:100) acts in the same way. Other astringents, such as sulphate of zinc, sulphate of copper, alum in gelatine capsules, are introduced into the vagina in a similar manner.

Great care must be devoted to disease of the portio vaginalis and cervical canal. Erosions of the portio vaginalis are

to be touched up; in suppuration from the cervical canal and uterus, the parts are brushed with astringents or injections made with Braun's syringe. Hypertrophy of the portio vaginalis with development of granulations requires vigorous cauterization, even partial excision, *i.e.*, surgical interference.

In chronic cases attention must always be paid to the general constitution. The nutritive disturbances, constipation and anæmia, which are so frequent in women, must be relieved by suitable remedies.

Menstruation indicates complete rest until a few days after its cessation, and vigorous cauterization is especially contraindicated.

Acute vaginal blenorrhœa may also be the subject of treatment during pregnancy, but, as a matter of course, with the utmost caution. The cure of chronic blenorrhœa under such conditions is a labor of Sisyphus, which it is best to put off until parturition is completed.

CHAPTER VI.

COMPLICATIONS OF BLENORRHŒA IN THE FEMALE.

I. VULVITIS.

General Remarks.

Among diseases of the sexual organs in the female, vulvitis occupies a position analogous to that of balanitis in the male.

Diseases of the vulva may occur independently as the result of various local irritants, and are then non-infectious, purely local affections, superficial inflammations, which, corresponding to the hybrid anatomical position of the vulva between integument and mucous membrane, also holds pathologically a position midway between catarrh and acute eczema.

Similar forms occur as part-symptoms of acute urethral and vaginal blenorrhœas. It has not been decided whether these vulvitides, which are so common as attendants of acute sexual blenorrhœa, are real blenorrhagic affections, or merely the result of irritation by the blenorrhagic secretion. The entirely analogous balanitis is certainly the effect of irritation by the secretion.

In children, on the other hand, there is a true, primary, blenorrhagic vulvitis, which is caused by the transmission of blenorrhagic, gonococci-containing secretion, and by the local increase of the cocci upon the vulva; it remains localized or extends to the vagina. Apart from Fraenkel's cases, which are not entirely clear, Aubert, Widmark, Cséri, Lenander and Israel have reported instances in which the presence of gonococci and usually the infection were demonstrated.

Symptomatology.

Although vulvitis usually heals rapidly and easily, it often produces very alarming symptoms. Whether it occurs alone or as a complication, it always gives rise to itching and burning

which soon increase to pain. The passage of urine over the inflamed surfaces is especially painful; movement, particularly walking, is also painful or even impossible. The second striking symptom is the abundant secretion of creamy, foul-smelling pus.

On examination in the most acute cases, the inner surface of the thighs, often almost to the knee, and the inter-crural folds, are reddened, partly eroded and weeping. The labia majora are swollen, reddened and hot. Their surface, especially at the edge, and the hairs of the pubis, are sticky, and covered with crusts of pus. The labia minora are often so œdematous that they protrude beyond the labia majora. Their surface likewise, together with the inter-labial folds, is reddened, swollen, partly eroded. The lining of the vestibule is intensely swollen, of a deep red color, loosened, often velvety, even finely granular. Deeper red patches or punctate, slightly elevated spots, which belong to the swollen follicles, are seen not infrequently. The vicinity of the excretory ducts of Bartholin's glands is also characterized by more intense redness. The entire diseased surface is covered with a more or less thick layer of pus, containing numerous micro-organisms, also gonococci if the disease is blenorrhagic. Their diagnosis, however, is often rendered very difficult by the multitude of other cocci and bacteria.

In addition to the acute purulent vulvitis just described, we also find milder, subacute, muco-purulent vulvitides, characterized by slight intensity of the subjective and objective symptoms.

Vulvitis usually terminates in recovery. It rarely becomes chronic, and only after gross neglect. The secretion then remains increased, slight itching and pricking become permanent, the lining membrane of the vulva becomes slightly thickened, of a slate gray to violet color.

Chronic vulvitis is more often localized. The process disappears from the surface, and retires to a number of glands, among others to the glands of Bartholin, which will be discussed separately. But the other vestibular glands may also take part in the affection—for example, the glands around the orifice of the urethra, the numerous glands and follicles on the inner surface of the labia minora, which are partly scattered, partly arranged in groups. In these localized, extremely

insidious forms, which are usually entirely devoid of symptoms, the vulva appears to be normal, pale red in color, and the secretion is not increased. It is only on careful examination that we find, at one or more of the places mentioned, one or a few dark red patches, often not larger than a lentil, whose mucous membrane is fluffy or velvety, even granular; perhaps a few swollen follicles, which can be better seen than felt, are situated underneath. A little secretion, mucus or muco-pus, can be squeezed from the excretory ducts of Bartholin's and the peri-urethral glands, and Schwarz states that small painful ulcers may develop from the suppuration of such follicles.

Diagnosis.

The diagnosis is made without difficulty from the symptoms mentioned. It is more difficult to distinguish the blenorrhagic from the non-blenorrhagic forms. It must be kept in mind that blenorrhagic vulvitis occurs only in children as an independent affection, but that it usually extends in such cases to the vagina. The demonstration of gonococci is usually not difficult in these cases. In adults vulvitis is rarely an independent affection, but is a link in the chain of an extensive blenorrhagic process, which usually involves the urethra, vagina and cervix. These parts should therefore be examined in vulvitis. The existence of vulvitis, while the urethra, vagina, and uterus are healthy, speaks against its blenorrhagic character. We must then examine for all those factors which are usually followed by symptomatic vulvitis, such as soft chancre, primary and secondary syphilitic lesions; finally, we must take into consideration those conditions which favor the development of idiopathic vulvitis, such as masturbation, uncleanliness and accumulation of sebum, pregnancy.

Treatment.

The treatment of acute vulvitis is quite simple. Washing with lukewarm baths and irrigations, insertion of cotton between the labia, into the vestibule and the inter-labial folds, in order to prevent contact of the inflamed parts, and absorption of the secretion, often prove sufficient. In more obstinate cases the application of astringents materially aids recovery.

So long as the inflammatory symptoms are violent, we may use plumbum aceticum basicum solution (ʒ iiss: ℥ vj.), into which pledgets of cotton are dipped and inserted into the parts. When the acute symptoms have subsided we may apply, in the same way, other astringents, such as tannin, sulphate of zinc, and alum in ½ to 1 per cent. solutions. In these cases the most effective agent is nitrate of silver in ½ to 1 per cent. solution, brushed upon the inflamed parts, which are then covered with dry cotton.

As a matter of course other blenorrhagic affections which may be present, must be treated in a suitable manner.

Chronic vulvitis is much more obstinate, and vigorous local treatment is indicated. The patches of infiltrated, swollen, perhaps suppurating glands can usually be cured only by the application of caustics. Brushing with concentrated solutions of nitrate of silver (1:10 to 5), with the solid stick or chloride of iron effect material benefit, but I have always found that the best plan is the use of the Paquelin cautery, whose finest tip, brought to a white heat, is carried gently into the larger follicles or is applied several times to reddened patches.

II. INFLAMMATION OF BARTHOLIN'S GLANDS.

General Remarks.

Inflammation of Bartholin's glands, extending from the vulva, is a frequent complication of blenorrhagic infection in the female. It seems to be a true blenorrhagic affection. At least Arning found gonococci in the pus of acute and chronic Bartholinitis, and this has been confirmed several times. Nevertheless Bumm regards it as the result of mixed infection, *i.e.*, the combination of gonococci and pus cocci. But although the suppuration of the gland must be attributed to other elements, the gonococci play an important part in the mixed infection, as shown by the fact that no affection of Bartholin's glands occurs among the large number of non-blenorrhagic vulvitides, but the former is always a complication of blenorrhagic vulvo-vaginitis and urethritis. Bartholinitis is also unknown in the blenorrhagic vulvo-vaginitis of children, but seems to occur exclusively in adult women.

a.—ACUTE BARTHOLINITIS.

SYMPTOMATOLOGY.

Acute Bartholinitis either develops directly as a complication of acute blenorrhœa or from an exacerbation of the inflammation in chronic Bartholinitis, even during long-standing chronic blenorrhœa.

It runs its course as a very acute inflammation with a tendency to suppuration. Whether as the result of acute recent or chronic inveterate blenorrhœa, it generally follows some exciting cause, such as neglect, forced coitus in prostitutes, excessive exercise. A swelling develops within a few hours in one of the labia majora, usually the left, accompanied by all the signs of acute inflammation, such as redness, elevation of temperature, intense pain. On examining the reddened, swollen labium majus (the labium minor of the corresponding side is usually implicated in the œdema) we feel, in the posterior third, a firm, tense, sharply defined nodular swelling, as large as a hazel nut, which can be felt distinctly beneath the integument of the labium. Pressure on this nodule discharges pus from the excretory duct of Bartholin's gland, though not in all cases. The inflammatory symptoms, the swelling and redness, increase for two or three days, and extend to the præputium clitoridis and to the inguinal region on the same side. The formerly sharply defined nodule loses its distinct contour and is lost in the general swelling; it becomes doughy, and finally (usually very soon) fluctuation is felt, which is first distinct upon the inner surface. The beginning of suppuration is generally signalized by chilliness; the pains, hitherto violent only on contact, become throbbing, dragging, shooting, and are also very severe spontaneously. After gradual thinning of the skin, perforation takes place, usually upon the inner surface of the labium, more rarely in the fold between the labium majus and minor. In very rare cases the pus perforates the capsule of the gland, but not the integument, and perforation may then occur into the perineum or even the rectum. Fistulæ may develop if the perforation occurs in two places at the same time. The perforation opening is usually quite large, jagged, with gangrenous or thin livid edges; the destruction not infrequently extends farther after perforation. The dis-

charged pus is bloody, foul smelling, not infrequently mixed with gangrenous shreds. These spontaneously rupturing abscesses and the accompanying gangrene often cause considerable destruction of tissue, which exhibits a rapid tendency to recovery as soon as perforation takes place.

The termination in induration is much rarer than that in suppuration. The inflammatory symptoms then subside before suppuration has begun, and the gland remains as a firm nodule, which soon becomes painless. The termination in resolution rarely occurs, however early treatment is adopted, and never occurs when the disease runs its course spontaneously.

TREATMENT.

The therapeutic indications are very simple. So long as there is no suppuration, vigorous antiphlogosis is indicated, rest and application of cold.

As soon as suppuration is demonstrable, surgical interference must be adopted. The pus must be evacuated as rapidly as possible by long incisions, the abscess cavity closed by antiseptic treatment, introduction of iodoform, irrigation with solutions of corrosive sublimate.

In the rare cases of induration poultices often produce absorption. Otherwise this painless but usually annoying symptom is relieved by excision and enucleation of the nodule.

b.—CHRONIC BARTHOLINITIS.

Chronic Bartholinitis occurs, although rarely, as a sequel of acute non-suppurative or partly suppurative inflammation. It occurs much more frequently as a complication of chronic blenorrhœa. In the former event the disease extends to the parenchyma of the gland, in the latter it is confined to the excretory duct. If the gland is affected it is usually felt as a painless, firm nodule, pressure on which discharges muco-pus or a milky, even clear mucous fluid. This secretion, whatever its appearance, usually contains gonococci, *i.e.*, it is contagious.

In other and more frequent cases increased firmness of the gland cannot be felt. We then find the mucous membrane around the excretory duct reddened, perhaps slightly loosened. Secretion is not discharged spontaneously. But if pressure is

exerted on the vicinity of the gland, a mucous, milky, gonococcus-containing secretion escapes, either in drops or in a large amount. The large amount of secretion is explained by the fact that cystoid dilatations form in the gland or its excretory duct, and that these contain the abundantly-produced morbid secretion until the walls of the cyst acquire sufficient tension or it is evacuated by pressure from without. If the patient is examined when the cysts are filled with secretion, the escape of muco-purulent fluid from the excretory duct very soon clears up the diagnosis. But if the cyst has just been emptied and no secretion appears, the redness around the excretory duct will, at the most, arouse suspicion. But we often cannot make a diagnosis of the affection, and hence of the fact that the woman is the bearer of an infectious blenorrhagic process, inasmuch as examination of the other genitalia is followed by negative results. Indeed, chronic Bartholinitis, like the disease of the peri-urethral follicles, is often the sole localization of chronic blenorrhœa in the female.

Both affections are important in this respect, particularly to the police surgeon, who must attend to the examination of prostitutes. If the inspection hour is known to the prostitutes, the latter, many of whom suffer from chronic localized blenorrhœa, may squeeze out the cysts, either intentionally or unintentionally, while washing the genitalia, and thus often remove the only appearance which may prove the existence of blenorrhœa and the infectiousness of the patient.

Chronic Bartholinitis, like peri-urethral and cervical blenorrhœa, explains some hitherto obscure points in the pathology of blenorrhœa.

It explains the fact, frequently observed by competent authorities, that a woman, from whom a man has undoubtedly acquired blenorrhœa, may be examined and regarded as healthy, if the examination is made at a time when the secretion from the peri-urethral or Bartholin's glands is not visible.

It also explains the fact that a woman may infect some, but not all, of several men with whom she has cohabited in rapid succession. Some found the secretion from the gland at the time of coitus, the non-infected ones did not.

Le Pileur (1877) was the first to call attention to the infectiousness of this secretion, and the gonococci which have been found in it remove all doubt.

The affection is extremely obstinate. It may exacerbate and lead to inflammation and suppuration under the influence of irritating causes. Spontaneous recovery is hardly ever to be looked for.

TREATMENT.

In chronic cases the excretory duct is always dilated, so that it is possible, by means of an anal syringe, to inject astringent and caustic fluids into the duct and its cysts. But I regard this method of treatment as unreliable and tiresome. It is always best to introduce a grooved director into the excretory duct, to incise the latter and the cysts, and then to destroy them by cauterization. If the gland is indurated, it should be enucleated.

III. INFLAMMATION OF THE UTERUS AND ITS APPENDAGES.

Our knowledge of the blenorrhagic affections of the uterus and its appendages is an acquisition of the last decennium.

It is true that, after the older writers, Heurter, Mercier, Ricord, Hardy, Rollet, Bernutz and Goupil had recognized the existence of uterine blenorrhœa, which was denied by Swediaur, West was the first who expressed the view that an acute inflammation of the uterus may occur during the course of acute blenorrhœa, may attack the tissue of the uterus itself, and also exhibit a tendency to spread along the tubes to the peritoneum. But this doctrine of an acute uterine blenorrhœa was not generally accepted, and Zeissl and Jullien regard uterine clap, strictly speaking, as a disease of the cervical canal alone.

Chronic uterine blenorrhœa with its sequelæ was recognized later than the rarer acute form. It is the undisputed merit of Noeggerath (1872) that he was the first to point out that, in the same way as acute uterine blenorrhœa results from acute infection, so chronic blenorrhœa in the male produces a chronic infection in the female, which first runs a latent course, but then, usually under the influence of external causes, exacerbates and gives rise to acute or subacute affections of the uterine appendages. This view, which was at first violently attacked, has only been fully accepted very recently, and has

been confirmed by investigations made on the basis of the gonococcus theory. One question alone still remains unsettled, *i.e.*, whether the gonococci alone can produce the changes which will shortly be described, or whether an effect is not also produced by other micro-organisms which have entered at the same time or later, and for which the soil has been prepared by the gonoccci. The question, therefore, is whether these complications are to be regarded as purely blenorrhagic or as the expression of a mixed infection.

The uterus and its appendages, when attacked by blenorrhœa, present various forms of disease, which are claimed by gynecology, and with which we will now concern ourselves very briefly.

a. Acute Blenorrhagic Metritis.—This disease is always the result of an acute blenorrhagic infection, and develops as the continuation of the blenorrhagic process in the vagina and cervical canal. Other symptoms of acute infection, such as urethral, vulvo-vaginal blenorrhœa, are also always present. Hardy reports a case of primary acute uterine blenorrhœa in which, unlike the ordinary ascending course, the symptoms of vaginal and urethral blenorrhœa did not develop until the end of a few days.

Acute uterine blenorrhœa, as the continuation of an acute infection, usually develops brusquely. Together with chill and fever, there appear rapidly increasing dull pains in the lower abdominal region and the small of the back. The patients, who create the impression of a serious illness, take refuge in bed on account of the exacerbations of the pain on movement. On examination of the genitalia we find, in addition to the previously mentioned signs of acute blenorrhœa, that the portio vaginalis is swollen and plump, its mucous membrane is reddened, perhaps eroded. Violent pain is produced by bringing the portio vaginalis into the speculum or touching it with a tampon. Muco-sanguinolent, then sanguino-purulent, finally purulent secretion flows in large amount from the cervical canal. On palpation the uterus appears to be enlarged and is very tender. After a few days the acute symptoms subside and the disease recovers or more often passes into the chronic stage. The inflammatory symptoms may also extend to the tubes, ovaries and peritoneum; in the severest cases they may give rise to acute purulent peritonitis with a fatal termina-

tion. The extension of acute blenorrhœa to the uterine appendages is shown in Mercier's case, in which the patient died of typhoid fever. The patient was a prostitute, æt. nineteen years, who had been suffering from blenorrhœa for several weeks, acquired typhoid fever, and during its course experienced intense pains in the pelvis.

The autopsy showed: the inner surfaces of the labia majora and minora were swollen and reddened, excoriated here and there; the labia minora covered with small granulations. The bladder contained a small amount of purulent urine; its mucous membrane, especially at the orifice, was reddened, likewise the mucous membrane of the urethra and vagina; the folds of the latter were deepened. In the posterior fornix were small granular vegetations. The portio vaginalis was reddened, the broad transverse os and the cervical canal were bluish red in color. The cavity of the uterus had a dark color like the lees of wine. The Fallopian tubes presented signs of inflammation and contained muco-pus. The peritoneum was healthy, except around the fimbria and ovaries, where it was reddened and adherent to these organs.

Peritoneal exudations into the pelvis, around the tubes and ovaries and in Douglas's *cul-de-sac,* are more frequent. These usually suppurate and perforate; absorption is rare. Ceppi (1887) found gonococci in a circumscribed peritoneal exudation which was opened through the vagina.

b. Chronic Blenorrhagic Metritis.—This develops more rarely than the acute form, and usually as a direct chronic complication of chronic blenorrhœa. It is observed particularly in young women whose husbands entered matrimony with a gonorrhœa which still contained gonococci. The cocci, whose virulence has been diminished by their long-protracted proliferation on the same soil, produce directly a chronic process. In many cases this is located in the vulva or its glands, but slight redness and the formation of granulations may also develop in the vagina. In other cases, however, the vulva and vagina appear to have been skipped and remain entirely normal, while the mucosa of the cervix and uterus is attacked at once. The morbid symptoms on the part of the vulva and vagina are mild and are attributed to the defloration, especially if they occur soon afterwards, and consist of burning and itching in the genitalia with somewhat increased discharge.

The symptoms proper do not set in until the uterus is affected. The patients then experience dull pain in the pelvis and small of the back, especially after bodily strain, excesses in coitus, before and during menstruation. Examination with the speculum shows swelling, redness, slight eversion of the cervical mucous membrane with a little muco-purulent secretion. Digital examination shows slight enlargement and tenderness of the uterus.

Strains and excesses, menstruation, but particularly parturition and child-bed, produce exacerbations. At the menstrual period the exacerbation begins a few days before the period as violent colicky pains, the period is usually delayed, the menstrual discharge very scanty, and the muco-purulent secretion very abundant for some days afterwards. The premature occurrence of the menses and metrorrhagia are less frequent. These exacerbations may also further the extension of the process to the perimetrium, peritoneum, tubes and ovaries.

Perimetritis.—Noeggerath distinguishes three forms:

1. *Acute Perimetritis with or without Parametritis.*—The patients begin to complain soon after marriage; they grow tired easily, the menses become profuse, finally acute, and violent inflammation sets in. Or pregnancy sets in, during which the patients complain of vague pains in the abdomen, and it is not until child-bed that an acute parametritis or perimetritis develops. Or, finally, the women are suddenly attacked, during complete health, by an acute, foudroyant, fatal parametritis.

2. *Recurring Perimetritis.*—This form is associated with purulent salpingitis. Purulent masses, which are retained in the tubes, escape under the influence of fear, excitement, coitus, introduction of the uterine sound, and give rise to circumscribed perimetritis. The first attack is always acute, the exudation abundant and purulent. The subsequent attacks diminish in intensity and extent. At each seizure the patient experiences a violent pain, associated with nausea, which lasts a few days and is located between the second and third thirds of Poupart's ligament. The pain disappears in a few days, leaving behind shooting pains after meals, neuralgias in the hips and abdomen.

3. *Chronic Perimetritis.*—This is manifested by latero-

version of the uterus, whose fundus is usually turned toward the right; tenderness in Douglas's sac, in which firm bands can be felt.

Salpingitis and Oophoritis.—Salpingitis is a frequent blenorrhagic affection—indeed, according to Sanger, it is the main site of the disease. We have already mentioned its connection with recurring perimetritis. Tait and Howard reported cases of gonorrhœal pyosalpinx. In Westermark's case a pyosalpinx was mistaken for extrauterine pregnancy and removed by laparotomy. The walls of the extirpated tube were infiltrated and thickened; in the purulent exudation were found typical gonococci. Ortmann's case is especially instructive. A woman, æt. twenty-two years, had been married for a year to a man whose history showed several attacks of clap. Eight weeks after the first confinement she was taken sick, and complained particularly of burning during micturition and violent pains in the abdomen. Examination showed enlargement of the left ovary, right oophoritis and salpingitis. Laparatomy and extirpation of both ovaries and tubes revealed: purulent salpingitis, hæmatoma ovarii, peri-salpingitis, and peri-oophoritis, on the right side. Catarrhal salpingitis, peri-salpingitis, peri-oophoritis, on the left side. Both tubes very sinuous and dilated, their contents purulent. A circumscribed abscess in the right tube. The right ovary as large as a plum and contains a cyst filled with blood, in addition to dropsical follicles. The pus in the right tube contains numerous gonococci which could be stained in a typical manner. The epithelium of the tubal mucous membrane is wanting; its folds have coalesced into high ridges, so that the deeper portions seem to be converted into cavities which are filled with blood and pus. The mucous membrane is thickened, markedly infiltrated, in a condition of purulent destruction in places, the muscular bundles are thinned, the intra-muscular connective tissue thickened.

CHAPTER VII.

COMPLICATIONS OF BLENORRHŒA IN BOTH SEXES.

I. GONORRHŒAL RHEUMATISM.

General Remarks.

Gonorrhœal rheumatism is one of the complications which attracted the attention of physicians at a very early period. Petrus Forestus (1507), Musgrave (1703) and Baglivi mention it as a proof of the syphilitic character of gonorrhœa. Swediaur describes it in detail. Hunter, Selle, Cooper, Brodie, Eisenmann, Baumés and Carmichael report cases and discuss its connection with clap. Eagle (1836) attributes it to the untimely use of copaiba and to improper treatment of gonorrhœa. But it is not until the appearance of Brandes's article (1854) that the history of gonorrhœal rheumatism really begins, and since then it has become generally known and studied, and the subject of numerous monographs, theses and discussions.

Etiology.

From the time that the clinical side of gonorrhœal rheumatism was discussed, the specific character of the symptoms, its course and connection with clap were determined, another question was broached, *viz.*, its origin and mode of connection with gonorrhœa. This question was the subject of many discussions, and gave rise to several theories that bore the mark of the study rather than of the anatomical laboratory.

The first writers who connected blenorrhœa and rheumatism, regarded the latter as a direct blenorrhagic disease, placing it in the same rank with epididymitis and prostatitis. But the observation that joint swellings may develop after other irritations of the urethral mucous membrane, especially after

catheterization, soon led to the view that blenorrhœa acted merely as an irritant of the urethral mucous membrane, which provoked the rheumatism. But this irritation produced by blenorrhœa was supposed to possess a specific quality because, as Fournier emphasized, it is only the blenorrhagic and not the other forms (catarrhal) of inflammation of the urethra which produce rheumatism. Zeissl also gave in his adherence to this view.

Other writers, however, particularly Thiry and Gurjon, adopted the opposing stand-point. They recognize no genetic connection between blenorrhœa and rheumatism, and believe that the blenorrhœa, as a depressing agent, merely favors the development of diatheses which have hitherto been latent in the individual.

To Guerin, Lorain and Lasègue the fact that blenorrhœa could produce remote localizations was a proof that it was a general disease. They believe that gonorrhœa has a long period of incubation and that no remote complications will ensue if we can master the disease while it still remains local, but that complications occur if the clap lasts beyond the stage of incubation. Martineau also favors this theory.

There is also a vaso-motor theory of the development of gonorrhœal rheumatism. This regards the disease as a vaso-motor disturbance, which is produced by reflex, vaso-motor irritants starting from the inflamed urethra. Lewin was the chief advocate of this theory.

The discovery of the gonococcus formed a landmark in this question. It would have to be regarded as a definitive proof of the pathogeny of gonorrhœal rheumatism if gonococci could be demonstrated in the pus or articular fluid of joints attacked by the disease. In fact, the statement has been made that the cocci were found in the pus of the diseased joints in a series of cases. In other cases, on the other hand, pus cocci but no gonococci were found. And so the question of the pathogenesis of gonorrhœal rheumatism is still undecided. One theory, based on the positive discovery of gonococci, regards the disease as a true blenorrhagic affection. The other looks upon it as an accidental secondary affection resulting from the fact that pus cocci, which are either present primarily in the diseased urethra or enter it secondarily, find the opportunity of entering the blood on account of the loosening

of the papillary body or the erosions and ulcerations to which the gonorrhœa gives origin; the pus cocci are then deposited in the joints, where they excite inflammation. The second theory, accordingly, regards gonorrhœal rheumatism as a mixed infection. This divests the disease of its specific character, because we are then unable to see why other affections, such as catarrh, traumata, the puerperal state, should not give rise to similar secondary infections. In fact, Lancereaux regards gonorrhœal rheumatism simply as a mere subdivision of his "arthrites genitales."

SYMPTOMATOLOGY.

Among 2423 cases of blenorrhœa Grisolle observed gonorrhœal rheumatism 68 times (2.8 per cent.), and Besnier and Jullien also give a proportion of 2 per cent.

It is more frequent in men than in women, though the latter do not escape entirely. Age exerts no influence. It only complicates true blenorrhagic affections and is never observed in pseudo-blenorrhagic diseases, such as balanitis. But the old belief that it only complicates urethral blenorrhœa is erroneous. Recent cases have been reported in which the joint affection occurred in blenorrhœa of the vulva, vagina and conjunctiva. Lucas describes two cases of blenorrhœa conjunctivæ in infants who suffered from swelling of several joints after birth; the course of the disease led Lucas to make a diagnosis of gonorrhœal rheumatism. Hartley reports cases of vulvo-vaginitis in girls of three, four, five, seven and eight years who were attacked by swelling of the joints. In four cases gonococcci were found in the secretion of the vulvo-vaginitis.

There are no accurate statistics with regard to the period at which the disease begins. But observation and the study of numerous reports of cases seem to show with tolerable certainty that it is not the recent but the older cases of blenorrhœa that are complicated with rheumatism. Roustan states that it does not develop before the third week after infection. Struppi makes the interesting statement that in his eight cases of gonorrhœal rheumatism the affection always followed disease of the pars posterior, which was also complicated by prostatitis in three cases. Loeb also regards gonorrhœal rheumatism as a complication of posterior urethritis.

The following statistics, collated from numerous writers, give the site of the disease:

Knee joint,	136 times.
Tibio-tarsal joint,	59 "
Wrist joint,	43 "
Finger joints,	35 "
Elbow joint,	25 "
Shoulder joint,	24 "
Hip joint,	18 "
Maxillary joint,	10 "
Metatarsus,	7 "
Sacro-iliac synchondrosis,	4 "
Sterno-clavicular joint,	4 "
Chondrocostal joint,	2 "
Intervertebral joint,	2 "
Peroneo-tibial joint,	1 time.
Crico-arytenoid joint,	1 "
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Gonorrhœal rheumatism usually attacks several joints, more rarely it is confined to one joint. Among 348 cases collected by Jullien, 205 were poly-articular, 143 were mono-articular.

Many attempts have been and still are made to construct for gonorrhœal rheumatism a special symptomatology which will always permit it to be distinguished from other diseases of the joints, but such attempts are fruitless. Although the disease possesses certain typical characteristics, it runs its course under various symptoms. We may furnish the following schema of the different varieties:

1. Articular Rheumatism	mono-articular	acute (arthritis).
		chronic (hydrarthros).
	polyarticular	acute.
		subacute.
		chronic.

2. Peri-articular (nodose) rheumatism.
3. Synovitis tendinum.

All these forms receive their characteristic impress as blenorrhagic diseases less from the clinical history than from the following circumstances: 1. They occur during a blenorrhagic urethritis and follow its course, acute exacerbations of the

former being followed by exacerbation of the rheumatic complication, remission of the former by remission of the complication, and recovery of both occurring at the same time. 2. On fresh infection there is a decided tendency to recurrence of the complication. 3. These forms, although they begin acutely, present less acute symptoms than true rheumatism, and always exhibit a tendency to pass rapidly into a subacute and chronic stage.

Arthritis Blenorrhagica.—This is the most frequent variety and is regarded as a prototype of blenorrhagic disease of the joints. It begins acutely or is preceded by a prodromal stage, consisting of malaise and tenderness in several joints. This is followed by very rapid onset of the arthritis. A rapidly increasing swelling develops in one of the large joints, usually the knee. The pain may be very violent or moderate, the exudation and tension usually very considerable, fluctuation always distinct. On account of the marked distention the joint is usually fixed in a semi-flexed position. The general symptoms accompanying this swelling are very acute in the first few days. Fever develops (with nocturnal exacerbations to 39.5° C. and morning remissions to 37.5° even to 36.8°) and continues for several days. But the symptoms of acute inflammation do not last long, although the exudation and the consequent swelling do not diminish. The pain and fever disappear, and merely a feeling of tension, due to the exudation, remains, so that the use of the joint is only hindered by the exudation. In the most favorable cases this subacute condition may disappear, by absorption of the infiltration, in a few weeks. But so long as any infiltration remains, an injury, especially one that causes an exacerbation of the urethritis, may produce an acute exacerbation of the process, with renewed fever and painful swelling. This exacerbation also disappears rapidly, but its frequent recurrence very strongly predisposes the process, which already exhibits a tendency to a chronic course, to pass into hydrarthros.

A rarely observed termination is that in suppuration. This is indicated by chills and violent fever during the acute stage. The swelling of the joint increases, its coverings, hitherto pale, become reddened, the pain increases in violence and becomes throbbing, pulsating. The capsule of the joint ruptures, the pus makes its way outwards between the sheaths of the mus-

cles and tendons. If recovery does occur, anchylosis results, but this variety generally terminates fatally by pyæmia.

Hydrarthros.—The chronic inflammation develops either directly or as a sequel of arthritis after frequent relapses. In the former event there is a gradually increasing exudation and therefore swelling of the joint, without subjective symptoms. The patient usually discovers it accidentally. On examination of the joint, which is entirely free from pain on pressure and passive movement, distinct fluctuation is felt, as the result of the accumulation of fluid. If this is marked, extreme flexion and extension are prevented, but otherwise the functions of the joint are intact. In extreme grades the joint ligaments seem to be loosened.

This results in an often very striking abnormal mobility of the joint, which impairs the use of the limb. The hydrarthros is capable of extremely rapid absorption and may disappear spontaneously in a few days, while in other cases it resists treatment for months. When the disease lasts a long time plastic changes usually occur in the joint. Some of the exudation is absorbed, but crepitation and creaking set in, and deformities develop which interfere partly or entirely with the functions of the joint.

Acute Polyarticular Blenorrhagic Rheumatism.—This variety possesses the greatest resemblance to acute articular rheumatism, develops rapidly as a painful, often considerable swelling of several joints, attended by a non-continued fever. But there are always certain differences between it and acute articular rheumatism. The number of joints affected is never as large as in the latter disease. There are usually only two (symmetrical) joints attacked, very rarely more than three or four. The fever is not as high as in genuine rheumatism. In the latter several joints are attacked at the same time, the blenorrhagic form usually consists of several attacks of monoarticular rheumatism, recurring at short intervals. The simultaneous acute affection of two or more joints is rare. The tendency to relapse after morbific influences which act upon the blenorrhœa, is also peculiar to this form. A further characteristic is shown by treatment. It does not react to quinine and salicylate of soda as promptly as genuine rheumatism.

Subacute Polyarticular Blenorrhagic Rheumatism.—

Next to arthritis this is the most frequent variety; it is analogous to the form just described, except that the fever never exceeds 38.5°; the subjective symptoms are slight or moderate, often in striking contrast to the considerable swelling.

Polyarticular Chronic Rheumatism, which develops directly or as the termination of the acute and subacute forms, is distinguished from hydrarthros merely by its localization in several joints.

Periarticular Blenorrhagic Rheumatism.—In both sexes this begins with a prodromal stage of malaise and dragging pains in the limbs. Suddenly a joint becomes swollen, but the exudation is not situated in the cavity of the joint. There is, on the other hand, marked infiltration of the periarticular tissue and firm œdema of the integument. The joint then appears to be thickened and deformed in a manner similar to that observed in gout. The pains are moderate, the fever is quite high at first, but soon disappears. The mobility of the joint is usually unaffected, indeed abnormal mobility may result. The affection generally recovers, but anchylosis is also observed.

Blenorrhagic Tendo-vaginitis.—This rare disease, which was investigated chiefly by Maymon, develops at all periods, but usually in older blenorrhœa, after the third week of its existence. It begins with chilliness and slight fever, followed by pains — one to several hours in duration — which appear and disappear in this or that joint or tendon. Finally the pain becomes fixed in the sheath of a tendon, which becomes the site of a doughy, painful swelling that simulates fluctuation; it often extends quite a distance along the tendon. At the same time the hitherto pale skin assumes a rosy to dark-red color, and finally becomes the seat of an often painful œdema. In the beginning of the acute stage the pain is violent and spontaneous, and is increased on pressure and movement. Later the spontaneous pains diminish, but the pain on movement often remains long after the swelling has disappeared. The disease attacks either a system of tendons which possess communicating sheaths, or separate tendons. The extensor digitorum communis, flexor pollicis, dorsal flexors of the toes, are the ones attacked most frequently. The acute stage, which lasts a few days, is followed

by remission of the inflammatory symptoms, but a period of several weeks always elapses before the exudation is entirely absorbed. Fresh infection or relapse of the blenorrhœa is followed by relapse or renewed disease of the sheath. The synovitis is very often combined with the various forms of arthritis.

Pathological Anatomy.

Although the number of autopsies in gonorrhœal rheumatism is not very small, we do not obtain from them a picture of the common benign forms, because the fatal cases are malignant but rare forms, which run an acute progressive course.

Fournier reports an autopsy on a case of acute suppurative blenorrhagic arthritis of the elbow. The joint was filled with pus, the articular cartilages eroded and entirely separated from the ulna, which was laid bare. Haslund describes four cases of purulent blenorrhagic arthritis, in one of which, that necessitated amputation, the knee joint contained ichorous pus, the cartilage was destroyed, the ends of the bones eroded, the periosteum separated by suppuration high up on the femur.

In a case of suppurative blenorrhagic rheumatism in a soldier, æt. twenty-five years, who died of pyæmia, Wyszrmirski found pus in both elbow joints and the left shoulder joint, and demonstrated gonococci in the pus. Pollard presented, before the London Pathological Society, specimens from a woman of nineteen years, who had suffered for thirty-six days from vaginal blenorrhœa. She suffered from fever, pain in the knee and stiffness of the right hip, and died of embolism of the pulmonary artery. The autopsy showed embolism of the left common iliac vein, the internal iliac and vaginal veins. The knee and hip joints contained pus, the articular cartilages were eroded.

Punctures and incisions furnish us with information concerning the nature of the exudation in cases which run a favorable course. Volkmann punctured a knee joint which was the seat of gonorrhœal rheumatism and removed four ounces of a mucous, greenish, slight cloudy fluid, which deposited, after standing, a sediment consisting of pus cells. The majority of the cells presented fatty degeneration; no epithelial cells were found. Laboulbene punctured the knee joint in two cases and evacuated a deep yellow fluid, consisting of sticky, alkaline,

purulent, cloudy serum; it contained pus corpuscles and fibrin, but no mucin. In one case Haslund removed about three ounces of sero-purulent fluid.

The punctures were also decisive as regards the question of the presence of gonococci. Petrone (1883) was the first to demonstrate them in the fluid of blenorrhagic arthritis. Kammerer also found numerous gonococci in one of two examined cases. Horteloup found them in a blenorrhagic sterno-clavicular joint. In the fluid aspirated from an inflamed knee joint Hall found large epitheloidal cells and a few pus cells, with gonococci in both as well as free in the exudation. Smirnoff detected groups of gonococci in the pus cells of a sero-purulent gonitis. We have already mentioned Hartley's positive cases. A few negative observations, on the other hand, have also been reported. But inasmuch as the positive appearances are based solely on microscopic examinations and not on cultures, skepticism concerning the nature of the micro-organisms is certainly justifiable.

Diagnosis and Prognosis.

The diagnosis of gonorrhœal rheumatism is evident from the symptoms. One of the most important diagnostic factors is the well-established fact that gonorrhœal rheumatism always exhibits a tendency, after it has appeared as a complication of clap, to return after fresh infection. The diagnosis is therefore undoubted if we learn from the patient that he also suffered from rheumatic symptoms during one or more previous claps.

The diagnosis is more difficult in a first attack of urethritis, or in a later infection in which rheumatic symptoms appeared for the first time. The possibility of the simple coincidence of clap and an independent genuine rheumatism cannot be laid aside. But even here there are certain data which furnish guides to the correct diagnosis. These include: 1. The small number of joints involved. Gonorrhœal rheumatism, often monoarticular, is rarely as polyarticular as genuine rheumatism, and seldom attacks more than two or three joints. Even in polyarticular blenorrhagic rheumatism the disease rarely attacks two or more joints at the same time with the same acuteness. 2. Diminished intensity and duration of the acute

symptoms as compared with genuine rheumatism. The fever and pain are not as marked as in genuine rheumatism, and disappear more rapidly, so that there is soon a disproportion between the persistent objective signs of joint disease and the rapidly developing apyrexia and absence of pain. 3. The occurrence of exacerbations of the rheumatism coincidently with exacerbations of the blenorrhœa. 4. Treatment. The action of quinine, salicylic acid and antipyrin, which is so prompt in true rheumatism, is very slight in the gonorrhœal form.

The prognosis should be guarded. Apart from the possibility of the occurrence of pyarthros, with all its grave consequences, complete recovery is often not effected even in the mild cases; the transition into hydrarthros may not be preventable, and thus the persistence of chronic disturbances (which are usually slight at first but are apt to be aggravated later on) must be regarded as a possible contingency.

Treatment.

The treatment hitherto has been a thankless task. Specifics are unknown, and we are therefore confined to symptomatic measures. Regulation of the hygiene and diet may prevent those influences which might cause an exacerbation of the blenorrhœa and therefore of the rheumatism. Heroic treatment of the gonorrhœa is to be employed with caution, because this is usually followed by temporary exacerbations of the urethritis, and these may influence the course of the joint disease.

In the recent acute stage we use antiphlogistics, but when the acute symptoms have disappeared and in the chronic cases we recommend absorbents, tincture of iodine, warm compresses, massage, sulphur baths, iodine preparations internally.

II. BLENORRHAGIC ENDOCARDITIS.

The knowledge that gonorrhœa may be complicated by cardiac affections dates back only to the middle of this century. Although blenorrhagic rheumatism was known earlier, many authors, for example, Trousseau, expounded the doctrine that it is never complicated by heart disease and is thus distinguished from genuine acute articular rheumatism. Brandes (1854) was

the first to report two cases of blenorrhagic rheumatism—one his own case, the other reported by Lehmann—which were complicated, the first by endocarditis, the second by pericarditis. Hervieux and Sigmund also observed, the former endocarditis, the latter pericarditis, as complications of blenorrhagic rheumatism. Desnos (1877) discusses blenorrhagic endocarditis and reported a fatal case with autopsy. Morel (1878) collected thirteen cases. Pfuhl mentions a case of blenorrhœa which was complicated by cystitis, conjunctivitis, polyarticular rheumatism, endocarditis and pericarditis, and recovered. Baudin reported a case of endocarditis without rheumatism. Up to date twenty-eight cases have been reported in literature.

Blenorrhagic endocarditis is, as we see, a rare disease which occurs in part as a complication of a rheumatism accompanying blenorrhœa, in part, but more rarely, as a direct complication of the blenorrhœa. Among the thirteen cases collected by Morel, in eleven the rheumatism and heart disease both appeared as complications, and only in two cases did the cardiac affection alone complicate the blenorrhœa. There is a striking predominance of the male sex. Sigmund is the only one who has observed the cardiac affection in women.

Concerning the etiology of the endocarditis we have been entirely in the dark, but Weichselbaum's case is calculated to shed some light on the question. In a patient who had an acute enlargement of the spleen, a gonorrhœa of three weeks' standing with mucous secretion containing gonococci, and who died of endocarditis, the middle aortic leaflet presented a deep loss of substance with abundant soft, grayish-white or grayish-red vegetations; the loss of substance extended to the adjacent aortic leaflet, to the mitral valve and through the wall of the aorta to the tricuspid valve; the free border of the left aortic leaflet was thickened. Streptococcus pyogenes was found by the microscope and by cultures in the vegetations on the valves. Hence endocarditis, like several other complications, must be regarded as the result of a mixed infection, and the gonorrhœa as an exciting cause which favors the invasion of the pus coccus.

The symptomatology differs in no respect from that of genuine endocarditis or of those forms which accompany true articular rheumatism.

The inception is either brusque, with high fever, chills and

the general symptoms of serious illness, or it is gradual and accompanied by moderate elevation of temperature and gastric symptoms. In the former event the fever reaches 40° or even 41° C. The patient is then attacked by a feeling of oppression and dyspnœa, the heart's action is violent and irregular, and may present auscultatory signs even at this time. At the end of a few days a remission occurs; this may continue or it may soon be replaced by an exacerbation. Embolism may lead to a rapid fatal termination during the first or a subsequent exacerbation. Or the affection passes from a remission into a chronic stage, and a valvular lesion with its consequences develops. The mitral valve is attacked more frequently than the aortic. The endocarditis may be complicated with pericarditis, the latter very rarely develops alone. In the acute stage the disease may extend from the endocardium or pericardium to the myocardium, and acute myocarditis may lead to a fatal termination.

In addition to Weichselbaum's case autopsies have also been reported by Desnos, Schedler and Fleury. Desnos's case showed mitral and aortic insufficiency. In Fleury's case there was extensive destruction of two aortic leaflets.

The prognosis, like that of ordinary acute endocarditis, is always grave.

The treatment is similar to that of the ordinary form of the disease.

III. BLENORRHAGIC EXANTHEMATA.

In 1781 Selle said "that blenorrhagic pus may be absorbed and give rise to cutaneous eruptions." This fact was subsequently overlooked and the eruptions which appeared during gonorrhœa were attributed to the so frequently administered balsam of copaiba. In 1866 Pidoux again called attention to the possibility of the complication of blenorrhœa by cutaneous eruptions. I reported three cases in which blenorrhœa and cystitis were complicated by purpura rheumatica, in one of the cases also by pleurisy. In all three cases relapses of the blenorrhœic cystitis were followed by renewed swelling of the joints and purpura. Other writers have reported similar cases. In all the eruption belonged to the group of angioneuroses, the various erythemata, both erythema multiforme and

nodosum, urticaria and purpura, and occurred either alone or associated with rheumatism. The symptoms presented no differences from the well-known course, so that we will confine ourselves to these few remarks.

IV. BLENORRHAGIC OPHTHALMIA.

Apart from the primary diseases of the eye which are due to direct communication of the blenorrhagic virus, blenorrhœa may also be complicated by secondary diseases of the eye, which develop with or without rheumatism. These are characterized as blenorrhagic affections particularly by the fact that they always exhibit a tendency to recur on renewed infection.

In the Reports of St. Bartholomew's Hospital (1852) are found a few cases of conjunctivitis and iritis which, together with rheumatism, complicated a blenorrhœa. Rollet described a blenorrhagic iritis. Guénan de Mussy reports the history of a young man who, in two attacks of clap, suffered from rheumatism, conjunctivitis, iridochoroiditis and keratitis. Galezowski gives a detailed account of "iritis rheumatismale blenorrhagique." Koeninger reports the case of a young man who suffered, during his first clap, from rheumatism, during the second from rheumatism and iritis, during the third clap from rheumatism and iridochorioiditis. Panas describes, under the term "keratite ponctuée," a form of iritis with deposits on the posterior wall of the cornea, which he claims to be a frequent complication of clap. Interesting cases are also reported by Schenkl, Haltenhof, Mengin, Kipp, Colsman and Seely.

Blenorrhagic iritis, a quite rare affection, is usually associated with rheumatism as a complication of blenorrhœa. Among twenty-six cases collected by Jullien, three were combined with the monoarticular form, thirteen with the polyarticular form. The symptomatology is exactly like that of rheumatic iritis—discoloration and impaired mobility of the iris, contraction of the pupil, and distortion of the pupil in the rare cases of posterior synechia, photophobia, ciliary injection. The cornea presents a smoky opacity. On lateral illumination and examination with the opthalmoscope this opacity is found to consist of a series of opaque, whitish points, which are collected particularly in the lower half of the cornea, often in

the shape of a triangle with the apex pointing upwards. The treatment does not differ from that of ordinary rheumatic iritis.

V. BLENORRHAGIC ADENITIS.

We have already discussed acute inflammation of the lymphatics of the penis in acute urethritis of the male. A similar acute lymphangioitis occurs, although more rarely, in the female. The lymphatics which pass from the clitoris and labia minora at the inguinal region, swell into round painful cords, over which the skin is reddened. In some cases the inflammation extends to the lymphatic glands, one of which, usually the nearest, swells into a painful nodule as large as a nut. It exhibits little tendency to suppuration, though this does take place in some cases. Bockhard found streptococcus pyogenes in the pus of such an acute suppurating adenitis, and it is therefore probable that we have to deal with a mixed infection.

In other cases, in cachectic, scrofulous, tuberculous individuals, multiple swelling of the glands occurs without symptoms of acute inflammation and almost without pain. This leads to the development of large bundles of firm glands, which remain unchanged for a long time, but are finally absorbed or undergo slow suppuration with the formation of fistulæ.

Finally, multiple painful swelling of the glands in both groins occurs in the beginning of very acute urethritis, but disappears with the acute stage of the primary disease.

The treatment does not differ from that of acute and chronic buboes.

ON

THE PREVENTIVE TREATMENT

OF

CALCULOUS DISEASE

AND

The Use of Solvent Remedies.

BY

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ON THE

PREVENTIVE TREATMENT OF CALCULOUS DISEASE.

LECTURE I.

EARLY HISTORY OF CALCULOUS DISEASE, AND THE TREATMENT BEST ADAPTED FOR ITS PREVENTION.

GENTLEMEN: We have had opportunities recently of studying together, and of examining very fully, the various operative proceedings which are generally practiced for the removal of stone from the bladder; and you have had the opportunity of seeing them performed many times, not fewer than eleven cases having passed through my wards during the last three weeks, and that each has been brought to a successful conclusion.

But, satisfactory as such a result is, it is impossible not to feel convinced that there is still an important question in relation to the treatment of this complaint which has not yet been adequately answered. And it raises an issue not less weighty, nor less intimately affecting the patients' welfare than any one of the subjects we have hitherto discussed.

The question I propose for solution is this:

Is there not a period in the history of the process which leads to the formation of renal or vesical calculus, whether in the condition of gravel, concretion, or stone, at which it might be possible to prevent the development of a considerable deposit and the necessity for mechanically removing it?

Admirable as it must be admitted are the results of modern

operative procedure, whether by the lithotrite or by the scalpel, and great as is the triumph which surgery has achieved in the art of removing stone from the bladder, I take it there are very few men who would not desire to avoid, if any means of doing so were available, the opportunity of personally illustrating these glorious successes of our craft. There is not one among us, indeed, who would not infinitely prefer to be furnished with the means of controlling or preventing the formation of calculus, on the first appearance of evidence that such a contingency is imminent or likely to occur.

I reply to the question before us, by a distinct assurance that we have the power to check the production of calculous matter at almost any stage of the complaint, and almost certainly to render it impossible, if proper treatment be adopted.

Before, however, entering on the details of the plan by which this result may be effected, I must first remark that there are, as you know, several varieties of calculus, and you may naturally ask, are all these equally amenable to treatment? For our purpose now, it suffices to regard all calculi as generally divided into two classes: those which have a local, and those which have a constitutional origin. By "local," I mean formed by diseased action in the bladder itself, and not depending upon any constitutional conditions or tendencies; and by "constitutional," I mean formed by some vicious action, some error of assimilation which has become more or less inherent in the system. Now, the large majority of renal and vesical calculi are of constitutional, and not of local origin. When they are local, we can do little to prevent their formation except by mechanical means. Calculous matter, the elements of which are produced in the bladder, may be washed out, or be broken or dissolved, and then washed out. But when stones are of constitutional origin—and we are going to refer entirely to these to-day—their component elements are separated from the blood, and no mechanical mode of preventing their production can by any possibility be available at this early stage.

Now, from observation, we know that nineteen out of twenty of such stones have uric acid for their basis, the remaining one in twenty being oxalate of lime (the deposits of oxalate of lime and of uric acid so often replace each other, that the consideration of the latter becomes practically gener-

ally sufficient for our purpose); and, less commonly still, there are phosphatic stones which are of constitutional origin also. Therefore, practically, to all intents and purposes, the problem before us is contained in the question: How may we best prevent the formation of uric-acid calculus?

Let us examine the early history of a case of persisting uric-acid deposit. First of all, let me say that, with some individuals in whom the tendency to manifest it is very marked, it is often more or less hereditary. As an illustration on the spot, let me recall the man we have just seen with uric-acid calculus in the ward, of whom we learned that his father had "gravel or stone for the last twenty years of his life." And it is by no means an unusual experience, that either calculus or gout—more commonly the latter—has been observed in the family of the patient who comes to us with one of these formations in the bladder. We speak of tubercular disease and of cancer as being transmitted by blood-relationship, especially the former; but it is probably not more strongly hereditary than the disposition to uric-acid deposits in one form or another. I have made a point of asking the question of all patients who come to me with this complaint; and although I cannot furnish you with an exact numerical statement, I do know that in many, either gout or gravel (for I wish to show you the identity in regard to origin of these two complaints) has existed in the preceding generation. This hereditary tendency varies in force or strength in different families. You will find some persons with persisting uric-acid deposits at thirty years of age or sooner, others at forty, others not until sixty. Of course, the earlier the age at which it appears, the stronger you will infer the hereditary disposition to be, and the more obstinate, probably, will be its tendency to persist.

What, then, are the first signs of this condition in the patient? The first thing which excites his attention, usually, is the frequent occurrence of a pinkish deposit at the bottom of the vessel in which urine has stood, often staining the surface more or less. Or, the secretion, passed originally perfectly clear and healthy in tint, has become thick and opaque (sometimes almost resembling a mixture of rhubarb and magnesia) soon afterwards. Or sometimes a delicate film or pellicle appears, and covers it, exhibiting a faint play of prismatic colors. In fact, these changes occur on the cooling of the

urine under certain conditions. These phenomena therefore may appear more frequently in winter than in summer, because the external temperature is lower. The change consists in a deposit of salts from a hot solution, as the liquid cools; the deposit being easily redissolved by raising the temperature of the urine to that at which it was originally passed, when it regains also its original transparency. The condition here described very often and very unnecessarily excites much anxiety on the part of the patient; but only a very marked and persisting condition of it can be regarded as a sign of what by some is called "the uric-acid diathesis." Mind, I mean strictly persistence, or, at all events frequency of occurrence: for you or I, with no hereditary predisposition, may take a little more beer, or a heavier dinner, than usual, or an extra glass of champagne, or a glass or two of extraordinary port, and may find next morning a considerable quantity of this pinkish deposit, or the urine looking almost like pea-soup, but not so thick, and when the vessel is tilted on one side, a tidal mark, so to speak, is seen, showing the height at which the liquid stood; all this, as I said before, being redissolved by heat. The same condition may occur also after unusual exercise which has produced abundant sweating, so that only a small quantity of water is available in the system for the solution of the urine salts, and the secretion is high-colored, and contains an unusual proportion of solids. In either case the opacity of the liquid, as well as its tint, which may vary from fawn to dull red, are due to the unduly large production of the mixed urates; that is, urates of soda, potash, lime, etc. But if, without any errors of diet, among which any but a very small allowance of alcoholic drink is only one, a patient habitually passes this kind of urine—if in time there frequently arrives also a deposit of uric acid, manifested by the presence of little crystals, looking like particles of cayenne pepper, or red brick-dust, at the bottom of the vessel—when this occurs rather early in life, say before forty, we cannot doubt that there is an undue tendency to produce uric acid, either inherited or acquired. For this tendency may no doubt be acquired, or a pre-existing habit may be intensified; indeed, it is often the result solely of improper diet and regimen. I now show you a specimen of urine quite cloudy with mixed urates, although you must be familiar with it in the wards, and also

with the fact that on heating the liquid it again becomes clear, and that in a short time, while we are talking, if the room is cold, it may again become cloudy on cooling. Let me once more remind you that this may occasionally happen with the most healthy individual; and it is only the persistence of the symptom, without any flagrant errors of diet, which should lead you to suspect it to be a constant condition that requires treatment.

We have followed the complaint up to the formation of cayenne-pepper crystals. Of this deposit I have some very good specimens here, which have been collected from patients who passed it habitually. These consist mainly of the transparent rhomboidal uric-acid crystals, which you know to be very beautiful objects under the microscope. They may be passed almost daily and habitually by some persons, and without any sense of discomfort, or occasion for complaining. Other persons may pass this material periodically in large quantity, little or none of the deposit being observed during the interval. At such periods, the patient often experiences pain in the back, or over one hip, with uneasiness extending to the groin and testicle, all this perhaps accompanied by sickness or nausea; and he may then be said to have a mild attack of sand or gravel. He feels relieved after the occurrence, which, just as a storm is said to clear the air, has freed him for a time from the effect of accumulation of morbid matter in the system. Sometimes, however, the symptoms are much more severe, and are often then believed necessarily to denote the passage of a renal calculus. But I have satisfied myself, after very large opportunities of observation, that in the great majority of these attacks, the patients have been merely the subjects of a "uric-acid storm," if I may use the expression; and that calculous matter has been eliminated in a soluble condition, although the process has been accompanied by pains sufficiently severe to arouse the suspicion that some concrete form of gravel has been passed, or has at all events been formed. These phenomena occur at varying intervals, and usually become more frequent or severe, unless the patient does something to prevent their occurrence. Subsequently, he may pass tiny calculi, which have the appearance of being rounded, or, at other times, rough and irregular aggregations of the same crystals. Or at a later period these bodies tend

in time to become larger, as large as small peas, or even beans; still specimens of the same product—that is, of uric acid, associated more or less with an alkaline base, such as those above named. Their transit from the kidney to the bladder may be accompanied by excruciating pain in the regions already mentioned, and by severe vomiting, lasting a few hours; after which relief often occurs somewhat suddenly. At the same time there are many large specimens of such "gravel" or small calculi passed without the patient being aware of the fact until he sees them excreted. Indeed it is by no means unusual, even in those instances where patients have voided such small bodies for a period of several years, that no pain or other sign of their existence is observed throughout. Where, however, the transit of the calculus is painful or difficult, some signs of it are generally manifest in the urine. Sometimes it is scanty, and merely very high colored; at others it is tinged with blood, and not uncommonly it deposits blood in that dark form which is described as resembling "coffee grounds."

Here, let me recall for one moment what I said as to the relation between gout and uric-acid deposit. I have sometimes seen these two complaints alternating, comparing one generation with another; gout, in its ordinary form of attack in the great toe, appearing in the one, gravel in the second, and gout again in the third. But the same individual may also have alternating attacks of gout and gravel. I have seen a patient who had suffered for years from gout become free from his attacks without known cause for several months, when he developed for the first time a uric-acid stone in the bladder. Lastly, the so-called "chalk-stones," which you have often seen infesting the knuckles and disfiguring the hands of elderly people in advanced stages of gout, are composed of the same material—that is, of uric acid, usually as urate of soda. The identity of gout and uric acid gravel, then, is unquestionable; they constitute two different series of phenomena, but both spring from one and the same root.

Now, what is the best mode of dealing with those patients who habitually pass the cayenne-pepper crystals of uric acid, or the small calculi? What mode of treatment will help to prevent the arrival of at least the advanced condition—namely, that of calculus too large to be voided by the patient? Gen-

erally speaking, I think such patients come under observation in a tolerably early stage, although it is obvious this is by no means always the case. Some are unnecessarily alarmed at a very early period, when the urine is only occasionally thick with urates. They are apt to mistake the opaque secretion for some important manifestation of morbid matter, and to become greatly disturbed in consequence. Indeed, some patients become almost hypochondriac through not knowing that such deposits are of little consequence at first, and can be easily treated. It is necessary to correct these false impressions, and explain the nature of the product, that in itself it is not a diseased one, only a normal constituent in larger quantity than is desirable. They should be made to understand that the original and normal form of urine is a more or less crystalline solid, that it is indeed passed thus by many animals; while in others, like ourselves, it must be first converted into a solution for convenience of storing in a bladder. This solution, then, owing to irregularities in diet, etc., occasional or habitual, varies in strength; and sand, gravel, or calculus can only be formed when the solution is maintained by undesirable circumstances in a too concentrated state. The urine is then generally found to be very acid to tests: of course, uric acid being in large quantity, that condition is a natural sign of its presence. It is little the worse for this perhaps; the bladder mostly tolerates a urine of full acidity quite as well or better than a neutral one. Nevertheless, the presence of a full proportion of acid has come to be regarded as sufficing to establish a principle, somewhat a crude one, of treating the complaint; and one almost universally adopted. In the circumstances described the patient has generally been prescribed the continuous use of alkalies. While, on the other hand, and with even less reason for such a course, when the urine is neutral or alkaline, mineral acids are persistently administered. This simple—indeed, too simple—view of the matter often dominates the whole of the treatment. In the former case, a certain quantity of potash, bicarbonate or citrate, or of soda, or of lithia; or benzoate of ammonia is administered for a long period; or the natural waters of Vichy, Evian, or Vals (carbonate of soda), Contrexéville (sulphate of lime chiefly, with carbonate of soda), or some other alkaline spring, are largely given; or the patient is perhaps sent to

drink the waters on the spot, there or elsewhere. The chief alkali is, as you see, carbonate of soda; whatever, however, be the form of it, provided enough be taken, these deposits will disappear; the uric acid will no longer be deposited; the urine will become less irritating; the annoying symptoms will be diminished or got rid of. And of course the patient is very much pleased with this new condition of clear urine and disappearance of all deposit. And you may naturally say, "What more can be desired?" Much: you have merely made his enemy disappear; he is by no means rid of its presence, for you have not checked the acid formation. The uric acid is there, and probably in quantity as much as ever; for the uric acid and urates are soluble in alkali, and you have only rendered them invisible. You really have the same condition as that described in the well-known fable of the ostrich, which is said to put its head into the bush when pursued by hunters, and, no longer seeing them, to believe itself secure. Just such is the security of the patient with uric acid who trusts solely to alkalies or to Vichy water. His surplus deposits have become unrecognizable by vision; nothing more. I do not go so far as to say the alkalies have been absolutely unserviceable as regards his constitutional state, but they will not improve it to any great extent; and when he leaves them off the acid shows itself again. And further, I believe there is reason to conclude that large quanities of alkali, habitually taken, exercise an undesirable influence, to say the least.

Diuretics have been employed on much the same principle, and may be regarded as no better than the alkalies. In those cases which are treated with such agents as nitrate or acetate of potash, etc., the secretion of water is no doubt increased *quoad* the amount of solids, and the solids are thus dissolved. The same thing happens with that remarkably general and always popular diuretic, so punctually and faithfully swallowed by the patient who has once obtained any medical sanction for its use—I mean gin, or whisky and water. In all such instances, what has chiefly been done is to stimulate the kidneys, already perhaps overworked, to do more. You have by no means cured the patient of his gravel, and may be happy if he is no worse for the remedies.

I shall endeavor to give you a sketch of such views as I have been able to form of the pathology of these cases; and,

speaking now with more confidence, I shall be able to point out an efficient mode of treating them. The problem they present has been brought before me with great force and frequency, since for many years my advice has been urgently sought by the calculous patient, after operation, as to what he should do to avoid becoming the subject of another. And many others in the early stages have sought similar aid, naturally feeling that the subject must have engaged my attention, in the earnest hope that they might escape the advanced stage.

Using then only broad and simple terms, as our time here and, I may perhaps add, the extent of our knowledge will not permit me to be more minute or exact in detail, I shall premise that the origin of those well-known symptoms which all agree to recognize as gout, as well as of a superabundant uric-acid deposit in the urine, is due to defective assimilation on the part of organs associated with or forming the primæ viæ. I am quite aware that it is common in practice to speak somewhat confidently of the liver, its action, and its states, although we have probably still much to learn about these. Many years ago it was the custom to talk and act as if we were thoroughly acquainted with the liver and its functions; but during the last fifteen or twenty years new light has been thrown upon the subject by the laborious researches of Bernard, Pavy, and others, and we have thereby learned how little we certainly know of its natural functions, still less of its action in disease. Thus, in the department of practical medicine, all were agreed that if there was one fact more obvious than another—at least since the time of Abernethy—it was the specific influence of mercury on that organ. Nevertheless carefully conducted inquiries render it doubtful whether the secretion of bile, at all events, is influenced by this agent in any degree whatever. There were other drugs, indeed, which were vaunted to take the place of mercury, yet always following at a humble distance, so to speak; but no one ever thought of disputing the fact that you could augment at will the bile secretion by administering that famous specific. I am not here to say whether that is so or not, but it seems to have been proved that there are substantial grounds for challenging our ancient faith in the doctrine so expressed. Observe that I have said nothing to underrate the value of the medi-

cine in regard of symptoms popularly associated with defects of some kind in the liver.

Bear in mind, then, that in speaking of the "defective action of the liver," or of "torpor of the liver," I merely use provisional terms, which most will easily understand as indicating more or less distinctly a certain set of symptoms. Let them be briefly described as mainly consisting of a constant, or almost constant, deficient excreting function by the bowels, sometimes, but by no means always, associated with impaired appetite, perhaps headache, nausea, depression, inactivity, and other signs of slow or uneasy digestion; some of these being absent if the diet is carefully selected, or if the patient lives in the open air and takes much exercise. On the other hand, not only the deranged digestion, but pains in the back and limbs referred to as muscular, may be frequently present. I cannot positively state whether those phenomena are really due to inactivity of the organ in question; practically, for us to-day, this does not signify much, but the current terms are still convenient formularies until better ones can be substituted for describing the condition in question.

Now, at the bottom of this tendency to uric-acid production there often lies what is thus understood as inactivity of the liver; and the true rationale of the unduly large formation of the urinary salts appears to be, that the liver together with the skin or some other organ performing inefficiently its excreting function, the kidneys have more work than is natural thrown upon them. Thus the solid matters of the urine, or rather some of its ordinary constituents, are augmented—not all of them, for urea is not necessarily increased, but uric acid is largely produced, and is eliminated not only in solution but in crystalline forms. Uric acid is very insoluble in water; and although the quantity thrown out may be quite soluble at the natural temperature of the urine (99° Fahr.), when this diminishes to 60°, 50°, or 40°, the acid is deposited, and when the quantity becomes larger still, even the ordinary amount of fluid associated with it at a temperature of 99° will not suffice to dissolve the whole, and solid uric acid is deposited in some part of the urinary passages. This deposit may take place in the kidneys themselves, giving rise, if not thrown off, to the formation of calculus, at first renal, but sooner or later generally becoming vesical. Now, if all this be so, the forma-

tion of uric-acid gravel is not by any means to be regarded as necessarily disease of the kidney; on the contrary, it may be regarded as the result of an active and capable organ vicariously relieving some other organ the function of which is torpid. The true remedy, therefore, is not to stimulate the kidneys, already overworked, by diuretics etc.—not, to use a familiar simile, to lash that horse of the team which is already doing too much work—but you are to seek the cause in that other one of the team which is doing deficient work, and that is, either in part or wholly, almost invariably the liver, in the sense already explained.

The treatment, then, which I advise you to pursue is to employ such agents as will stimulate the excretory action by the primæ viæ without depressing vital power. No doubt that a powerful agent for the purpose is mercury; and it is quite unquestionable that relief of the symptoms above alluded to is to be obtained in a remarkable manner by occasional small doses of that agent. For our purpose, however, it is not always necessary to use it, and there is a widely spread belief, grounded, in my opinion, on the reckless mode of administering the drug commonly followed in the early part of this century, that it is mostly injurious or dangerous, and to be discarded if possible. No such objection at all events lies against another class of remedies, the prolonged use of which has been of great value, I mean certain kinds of natural mineral waters. These I regard as greatly superior for the cases in question to taraxacum, nitric acid, podophyllin, the alkalies, and other vaunted "substitutes for mercury" as they are termed, in what is called "promoting the action of the liver."

Now the mineral waters which I am about to describe belong to a group of springs marked by a common and distinctive character, since all contain in solution sulphate of soda in considerable quantity, together with a varying proportion of sulphate of magnesia, besides less important salts. In studying these waters I wish you to observe with me the composition of them, and at the same time to dismiss to a certain extent from your mind the estimate of medicinal doses which you have acquired in the dispensary, and which necessarily belong to it; since small quantities of drugs, as they exist in mineral waters, act more freely than the same quantities combined after the ordinary pharmaceutical method.

You ask me for a demonstration, and I am quite ready to give it you. At the same time, let me caution you against regarding the small doses of mineral waters as having any affinity either in the matter of quantity or by the principle which regulates their administration, with what is understood as an "infinitesimal" dose. The difference may be illustrated thus: you know that you may give to A an ounce of "Epsom salts" (sulphate of magnesia), or to B half an ounce; for individuals are very differently affected, and each is probably freely purged; but the same effect will be obtained with one-third or one-fourth of those quantities if the patient takes it as prepared in Nature's laboratory—that is, in the form of mineral water. It is a curious fact, which I give as an ultimate one, and without speculating here on the cause of the difference. As a proof of the superior force of the saline combinations found in natural springs, I may refer you to the following experiment. If you will reduce by careful evaporation, as I have done, such mineral waters to their pharmaceutical condition of crystallized salts, you will find that they possess no more power than similar salts obtained by the ordinary commercial processes, and met with in every chemist's shop. Having been separated by evaporation, they no longer act with the energy which belonged to them when in the state of solution which the natural spring produces. You will therefore readily understand that it may be essential, at all events that it is desirable, to employ the natural mineral waters; since what are called "artificial waters," however admirably prepared, are simply pharmaceutical products, and are destitute of a remarkable quality which distinguishes the remedies they are designed to imitate.

	Sulphate of Soda.	Sulphate of Magnesia.	Carbonate of Soda.	Other Ingredients.
SALINE.	grs.	grs.	grs.	
Püllna	154	116	—	
Hunyadi Janos	150	148	—	
Friedrichshall	58	49	—	
Marienbad (Kreuz)	48	—	9	Little Iron.
Carlsbad (Sprüdel)	25	—	13	
Franzensbad	30		6	Little Iron.
ALKALINE.				
Vichy (Célestins) about	3	—	47	Little Iron.
Vals (Madeleine) about	—	—	65	Little Iron.

Here is a table of the waters which I refer to, with a com-

parative synopsis of their distinguishing saline contents, representing the number of grains (without estimate of the chloride of sodium and other less active agents which are also present) in an English pint. Below these I add two well-known alkaline waters.

The most concentrated water of the saline group is that of Hunyadi Janos, a Hungarian water which contains about two and a half drachms each of sulphate of soda and sulphate of magnesia in an English pint; next and nearly equal to it, is that of Püllna, which contains 154 grains, or about two and a half drachms, of sulphate of soda to the pint, and nearly two drachms of sulphate of magnesia. (The large demand which has arisen in this country for the "bitterwassers" or natural aperient waters of Germany has, of course, led to the appearance of new varieties. Thus, more powerful and so called "richer" products have come into the market. It should be known that the increased proportion of the aperient salt to the water in which it is dissolved is caused by artificially evaporating the product of the spring. Thus a constant quantity of the solids is maintained by carrying evaporation to a fixed point, determined by the specific gravity of the solution. Water having been thus artificially removed, there is no objection to the addition of a considerable quantity of hot water to them when used here, for the purpose of diluting the solution, but chiefly for raising the temperature to at least that of the interior of the body, a condition which appears to render their action more certain and prompt. The difference in the composition of these waters is not great. Those that contain the largest relative proportion of soda sulphate to magnesia sulphate are, I think, superior for the purposes referred to above.) Those quantities of the commercial salts would give a tolerably efficient purge to most persons. But you must not give a pint of these natural waters to any one; five to seven ounces would be a full dose. I do not like Püllna generally for our purpose, because it purges too freely, often gripes, and is very nauseous; Hunyadi Janos is less so. Half or two-thirds of a drachm of sulphate of soda and half a drachm of sulphate of magnesia in a natural mineral water is an average efficient aperient for a man. Supposing that we order Friedrichshall, which contains not a drachm of sulphate of soda in a pint, and little more than three-quarters of a drachm of sul-

phate of magnesia; yet nine or ten ounces make an efficient purge; for many persons six or seven suffice. I think I may say that seven or eight ounces is, for the adult, an average dose; it should be warmed and diluted by adding, say, a third or a half of its bulk of hot plain water. But I know no difference between this and Hunyadi Janos except that of the latter two-thirds of the quantity named is an equivalent dose, and is more convenient in consequence. If then a dose of either be taken in the early morning, an hour before breakfast, which should be a light meal, but comprising the cup or two of hot fluid usually then taken, a full, free action of the bowels will probably follow soon after; perhaps two. That quantity, you see, would contain about twenty-five or thirty grains of sulphate of soda and twenty or twenty-five grains of sulphate of magnesia, which, administered in any combination you please from a druggist's drawer, would have little appreciable action; the patient might be uncomfortable perhaps, but there would rarely be any marked action of the bowels. To repeat what I have said: if you evaporate a quantity of Friedrichshall or Hunyadi Janos water in a warm-water bath so as to avoid decomposition of the salt, and retain the water of crystallization, thus obtaining as perfect a product as a chemist can produce, and administer three times as much of this salt as that which exists in a dose of the natural water, you will probably not produce such efficient or certain results as the small quantity contained in the natural water ensures. So that there is something, which I do not pretend to explain, and certainly shall not speculate about here, which distinguishes the action of mineral waters from the action of salts which are made by our pharmaceutical processes. I may appropriately remark here also, that the action of the aperient bitterwasser on some persons is such, that the longer it is taken the smaller is the quantity necessary to attain its object. If, for example, six or seven ounces taken in the morning with, say, four ounces of hot plain water, produce one movement of the bowels immediately after breakfast, the next morning five ounces, and a morning or two later three or four ounces will do the same; and it is not improbable that at the end of ten days or so, three ounces or thereabout will produce the desired effect.

The next water on my list is that of Marienbad, and it contains forty-eight grains of sulphate of soda in the pint, with

nine grains of carbonate of soda, no sulphate of magnesia, but a small quantity of iron. With these constituents, there is enough free carbonic acid to make it an agreeable and slightly sparkling draught. Rather more than half a pint produces for most persons an easy motion. If this water is exposed to the air for a day or two, there will be a brown deposit of the iron; it is indeed to be regarded as a slightly ferruginous water although this character is not an important one. It is a very admirable form for many persons where the action is not required to be considerable; while the presence of iron, and of carbonate of soda, is an additional advantage for some. The only drawback is the need that it should be obtained in a fresh condition, for it bears transport badly, soon losing its carbonic acid, and depositing its iron, and thus becoming less palatable and light for the stomach. This difficulty has been partially overcome of late by the use of better bottles, and by the increased demand which is gradually arising for it.

Thus much for the saline aperients. We now come to the water of a very famous spring, that of Carlsbad, which is credited with the possession of a quality or influence, conventionally denoted by a somewhat vague term, "alterative," being undoubtedly useful for patients who habitually consume more food than the system and its activity demand, and who manifest, as a consequence, obvious signs of superabundant uric-acid deposit. The patients, however, should be fairly robust; feeble and excitable persons are usually depressed and injured by Carlsbad. There are several sources there, all of which contain about twenty grains of sulphate of soda, and thirteen of carbonate of soda in the pint, and contrary to the common belief are identical in their chemical constituents and proportions. They differ from each other solely in point of temperature, which is very high in the Sprüdel, the central source, and in the remotest is higher than that of the human body. Carlsbad water is often supposed to be purgative, but it is not so unless taken very largely. No quantity ever given here exerts a laxative action on the bowels. The influence it exercises on the animal economy, although probably chiefly due to the sulphate of soda element, is not in any way as an aperient. The "Carlsbad Salts" (which are widely and popularly known as an aperient, but are sold at an exorbitant price, bringing a

great revenue to the Carlsbad makers) are simply sulphate of soda, or "Glauber's salts" (with perhaps a trace of carbonate) and differ in no respect, except in name, from that common but valuable aperient as made here at home and in other countries. My belief, after a long and large experience of the employment of Carlsbad water in this country, is that in most instances it is more useful here than when taken at the spring itself. This I will explain presently.

Next to be named is the water of Franzensbad, which contains thirty grains of sulphate of soda, six of carbonate, and a little iron, which Carlsbad does not. That closes this group of springs.

Next I shall just point out the distinctive characters of the alkaline waters which are so popular in this country. First and best known is that of Vichy, which contains only three grains of sulphate of soda, but nearly fifty grains of carbonate of soda, in the pint—a powerful solution. After that is the water of Vals, which is also from the volcanic district of France, some of the springs of which contain upward of sixty grains of carbonate of soda in the pint, and nothing else worth mentioning. These two waters are extremely famous, and their sources are much resorted to by patients for the cure of gout and gravel. The waters are also largely exported to other countries. Another alkaline water is that of Evian, on the south shore of the Lake of Geneva, which I name here because it has a certain reputation as a resort for calculous patients. The alkaline constituent, carbonate of soda, is present, however, in much smaller quantity than the preceding, and this spring ranks, as regards the influence of that agent, below the others named.

Contrexéville and its water have of late been more recommended, especially by the profession in Paris, for calculous patients. No doubt some alleviation of symptoms is thus obtained by certain patients; but the constitution of the water, which depends for its alkaline action chiefly on a salt of lime, renders it an undesirable agent for the object we are now seeking to accomplish.

Under the continued daily use of strong alkaline waters, the uric-acid deposits disappear—that is, they are dissolved by the alkali. Inasmuch, also, as this appears to have some beneficial action on the liver, a certain degree of benefit is

perhaps also attained. Thus such patients are often better for a time after a visit to Vichy; but, as a rule, are not permanently benefited. I am satisfied, after observation on the spot, and also of the effect of the waters taken here, that they only temporarily mitigate the complaint, and do not cure it. Now, the principle upon which the waters of the sulphate of soda group, aperient and non-aperient, are beneficial is, that they produce activity in all the digestive functions, stimulating the excretory action of the abdominal organs, so that certain waste matters which have been hitherto thrown out as uric acid by the kidney are eliminated in some other form. If, therefore, it is really desirable to recommend resort to a mineral spring as treatment for uric-acid deposits, I should prefer Carlsbad, and certainly never send a patient to Vichy, Vals, Evian, or Contrexéville. And when a stout active man, whom it is most desirable to separate from his home engagements and business cares, requires a Carlsbad course, he may often visit the locality with advantage. At the same time, as I have already intimated, I firmly believe that it can in the majority of instances be more successfully pursued at home, provided certain concomitant advantages can be secured, than by sending the patient abroad. Thus it is desirable to secure, during a course of waters at home, at least regularity of meals, scrupulous attention to diet, and to select a time when, particularly in the case of business men, less of anxiety and of need for overexertion than usual, may be expected. Granted these conditions, there is one advantage in the home course which outweighs much of the special value of a course on the spot. The patient who stays at Carlsbad three weeks, very rarely four, is made to consume far too large a quantity of water in a given space of time. The quantity in itself is probably not too much for his needs; but it is more efficacious, and is less exhausting in its effect on the patient, to devote two or three months to the task than to swallow the whole within the brief term named. It is the apprehension of this fact which has made me so warm an advocate for the systematic home use of these agents, at all events for the class of cases which we are here considering. There are some other maladies for which Carlsbad is recommended, but relative to these it is not my province to offer you any opinion here.

But I shall now endeavor to illustrate with more detail the

manner of administering the waters which I have pursued and now advise.

A patient seeks your aid, on account of a series of severe renal attacks occurring at considerable intervals of time, after one or two of which he has passed small pisiform calculi of uric acid. His health may appear to be otherwise good. On the other hand he may be also troubled with some indigestion; in either case he is very likely more or less constipated; and you will probably find that, relatively to his activity of life, his amount of food and stimulant are somewhat excessive. I advise you to give him at the outset half a grain or a grain perhaps of blue pill with three or four grains of the compound extract of colocynth at night, followed next morning by six or eight ounces of Friedrichshall water, or half that quantity of Hunyadi Janos, taken with a little hot plain water. Then, on each succeeding morning, let him take six ounces of Carlsbad, with about two ounces of Hunyadi Janos, and four of hot water daily, say until the end of the first week. If the bowels are not moved at least once easily, soon after breakfast, increase a little the quantity of the aperient water; if, on the contrary, there is more than gentle action, diminish the dose. I then usually order four, five, six, or seven ounces of Carlsbad every morning, according to the patient's condition and temperament. If he is delicate, irritable, more distinguished by activity than by force, his occupations demanding intellectual rather than muscular exertion, the smallest amount may amply suffice. If he is a robust countryman, taking much physical exercise in the open air, the largest quantity may be a moderate dose. For two or three weeks or thereabout, the waters may be taken every morning; after that, every other morning for another month or more, and so on according to circumstances. The Carlsbad should be the chief agent throughout, but since it has no aperient action, with some people appearing rather to induce constipation, and as moreover the presence of the water in the system, for a few hours after taking it, sometimes seems to cause uneasiness and to be injurious rather than the reverse, it is desirable for a large proportion of patients to add a little Hunyadi Janos, just enough to induce one gentle action of the bowels after breakfast. The quantity of this must be decided by each individual according to his own experience of its effects. When the

bowels act freely without it, as occasionally happens, the Carlsbad may be taken alone; and in all cases it should be heated. At the source it is too hot to drink, and is allowed to cool slightly; and when it is taken here a little hot water may be added, or it should be raised in temperature to 90° or 100°, by placing the tumbler containing it in a vessel of hot water for a few minutes.

I have largely and systematically employed these agents for about five and twenty years, modifying the quantity and the mode as experience has indicated, and the system thus briefly described is the result of it. After a course of six weeks or so it may be repeated with advantage, for many patients after an interval of three or four months. Meantime, as an occasional aperient and as a corrector of digestion in these cases, few things are better than the aperient waters named. I referred just now to the well-known "Carlsbad salt" as being often used in the belief that it represents Carlsbad water; on the contrary, it consists almost entirely of sulphate of soda taken from the water, and has just the same and no more virtue than that salt when obtained from any other source. But sulphate of soda is one of the most admirable medicines we possess, and deserves to be more popular than it is. I have constantly ordered it, with or without a small addition of sulphate of magnesia, for the out-patients of the hospital, as the best substitute within their reach for the mineral waters in question.

There are many cases, especially those in which the patient has been in the habit of consuming more food, and especially more fatty material, than he has been able to assimilate, for which a few small consecutive doses of blue pill may be most usefully employed. I am quite satisfied in most instances with an eighth of a grain combined with two or three of the compound extract of colocynth, or with four or five grains of compound rhubarb pill, taken every third, fourth or fifth night, during the former part of the course. Many persons in whom doses of two or three grains of blue pill cause painful depression derive manifest benefit from the small quantity named. If anyone whose habits or condition have occasioned beneficial recourse to the remedy doubts the effect of an eighth, a twelfth, or even a twentieth of a grain of blue pill, let him try the ordinary five-grain compound rhubarb pill, with and without the

fractional addition, and the difference will be easily understood and appreciated.

And smaller doses even than these are of great service when habitually taken for a short time by some of these patients who have been the subjects of indigestion. Heavy feeders, large consumers of animal food, are little affected by such minute quantities. But when the habit of living largely on cereals, vegetables and fish, with perhaps game and poultry, and little or no meat, has been acquired—which, as we shall soon learn, is a powerful means of checking uric-acid deposit, and rendering the individual hitherto affected by it not only free from his local troubles, but stronger and healthier than before—the minuter doses referred to act with ample effect.

Of this system of treating a constitutional tendency to excrete uric acid in abnormal quantity, whether in the form of calculus, or by the less obvious course of gouty attacks in all their varied manifestations, I cannot speak too highly. I know no results in my entire personal experience of practice which have satisfied me more, or have better earned a right to be considered successful than those which have been thus attained.

But the important subject of the necessary dietary and hygiene for these cases must now be deferred to the next lecture.

LECTURE II.

THE DIETETIC TREATMENT OF PATIENTS EXCRETING URIC ACID IN EXCESS.

GENTLEMEN: A growing experience of man and his needs, and especially of that class of our follow-creatures who on account of some defect of health come under professional observation, has increased my sense of the importance of studying closely the subject of diet and digestion in relation to their ailments whatever they may be. Emphatically a surgeon, I nevertheless find that subject full of interest, and, what is more, believe an acquaintance with it to be the necessary complement of surgical tact and prowess: inasmuch as the right understanding and management of the stomach and its wants, in a sick-room as well as out of it, conduces largely to the success of operative treatment. I request you, therefore, not hastily to conclude that I am quitting to-day—no, not in the smallest degree—the surgical track which is my department here, but, on the contrary, that I am distinctly and essentially remaining within it. Hence it is that for the first time I take the course of extending the remarks on diet which formerly occupied but the latter third of a preceding lecture, for the purpose of expounding my views thereon more fully than heretofore.

You will recollect that in considering the early history of calculus, I suggested to you a point of view from which the patient excreting uric acid in excess might be regarded, and at all events successfully treated, chiefly through the influence of certain natural mineral waters containing sulphates of soda and magnesia, which act primarily on the organs of digestion. And it is therefore only natural to suppose that the right regulation of the diet of these patients must accompany the medicinal treatment. Indeed I am quite satisfied that in nineteen cases out of twenty, probably in a larger proportion than that, an undue deposit of uric acid will disappear under a proper

dietary. At all events, the formation of it in calculous masses can be prevented, and the patient spared the pains and the anxiety connected with their production and appearance. I think as much may be said of oxalate of lime deposits.

It was formerly held that when a patient excreted uric acid superabundantly, that the obvious and chief course is to diminish considerably the nitrogenous elements of his food, since uric acid contains a large proportion of nitrogen. But this very simple view of the matter will not furnish the secret of successful treatment, as the endeavor to realize it in practice has long ago demonstrated for myself, and a like conviction must also have arrived to others. For many years past I have pursued a widely different course, and with results which warrant the statement just made.

Speaking then in general terms, the two classes of food which it is necessary to eliminate from the dietary of those who have been excreting uric or oxalic acid abundantly, but especially the former, are, fatty matters, and saccharine products of all kinds: the former not entirely, the latter as completely as possible. Next, alcoholic drinks should be forbidden, or, if permitted in some exceptional cases, should be taken only in very small quantity. Let us get rid of this subject first before proceeding to that of food properly so called. There is no doubt whatever, that the great majority of these patients are better without fermented or spirituous liquor in any form. Its habitual use for healthy persons is undesirable and injurious as a rule, to which there may possibly be a few exceptions in this world of infinitely varying conditions. And for patients with impaired digestive power it is usually still less desirable. For those who have the symptoms before described as depending upon a "torpid liver," alcoholic drink of any kind is, I believe, invariably pernicious; its daily use in very small quantity creates the condition so termed for thousands, and is the cause of an infinite number of chronic cases of obstinately recurring, although slight, "sick headache," "bilious attacks," as well as much of the malaise, and incompetence, mental and bodily, attributed to a slow digestion.

But after long indulgence even in a small quantity of alcoholic stimulant, many a patient misses it exceedingly, and when commencing a habit of abstaining rises from a meal, however ample, complete and varied in the matter of provi-

sion, with a sense of dissatisfaction only to be appeased by that little modicum of liquor which has been absent. Of course this is the expression of a want artificially created, and it is very hard to stifle that craving. It will make itself felt for months perhaps—I speak of exceptional cases—and explains many of those in which an individual tells you, "I tried total abstinence for six weeks, or two months, and found I could not stand it." I will even concede that for a time he may have digested less easily and profited less by his food than he did when he took the stimulant; but this condition you may assure him will continue only for a time. Perseverance in abstinence, with a rarely permitted recourse to relief in unusual circumstances, will be rewarded in the course of a few months. Three, four, or even six, may pass before the digestive functions will regain their normal power apart from the artificial stimulus, and then they work better than before; and thus the patient reaps, if he faint not, the reward of his well-doing. When you admit some compromise in the matter, generally advise a sound light wine, the ordinary produce of the Moselle if possible; in its absence, that of the Rhine, or (now more difficult than formerly to obtain pure of common table quality) Bordeaux. But certainly forbid most champagnes and other effervescing wines, as for the most part imperfectly constituted, and always bad if containing much of the sweet compound often largely added and known as "liqueur." The stronger wines, as sherry and port, are always unsuitable, and strong beer is to be absolutely forbidden. Very light bitter beer, or sound cider which is neither sweet nor acid, is preferable to any of these if any alcoholic stimulant is to be taken. They might be so made in this country as to be at all events as wholesome as any wine wherever it comes from. It is a pity we do not produce here a very light alcoholic beverage from malt and hops which might be less injurious, and infinitely cheaper than any compound which is imported from abroad. While the apple, and possibly other fruits, with increased skill in the making would offer agreeable variety. All such products should be perfectly dry, that is, containing no free saccharine. Solutions of pure spirit and water may perhaps be permitted by exception for a very few of those who really require such stimulus.

But it is in the matter of food that there can be no com-

promise if it is intended to arrest the progress of calculous formation when it has once commenced. I have but one preliminary observation to make, always essential to be considered before defining strictly a dietary for any person. It is this: that when proposing to lay down a plan of this kind, whatever the object in view, the prescriber must ascertain the patient's habits, and especially what amount of bodily activity is habitually enjoyed, or demanded by the daily occupations of his life. It should be unnecessary to tell you, that where severe or prolonged muscular exertion must be sustained, in laborious occupation or in the pursuit of sport, more hydrocarbons and a little more nitrogenous food are desirable than for the sedentary man whose time is chiefly spent at the desk, in the office, in the courts, in the studio, in the carriage, and who has, moreover, but little opportunity for exercise. Make yourself acquainted with all his habitual modes of expenditure in the matter of physical energy, before furnishing detailed instructions as to the food which is to support it.

And not less is the age of the patient a matter of considerable importance. Let me insist on the truth of a doctrine which ought to be more familiarly known and acted upon than it is, viz., that all who have reached an age at which capacity for active exertion is diminished, should maintain a similar abstinence from such food, in order to insure a continuance of health and comfort. There is no more common, and perhaps no more flagrant popular error than that which is responsible for the practice of constantly "supporting," as it is termed, those who manifest the debility of age by augmenting their supply of food. It should be remembered, that all excess of nutriment over the power to assimilate, and also to employ in healthy activity when assimilated, must inevitably overtax the excretory powers, and become a source at least of discomfort, if not of disease. In short, when sedentary or generally inactive habits are induced, whatever the cause, whether through debility, accident, or age, highly nutritious diet, and especially a large proportion of hydrocarbons, is almost invariably prejudicial. This being premised as a general principle, I shall add that, for the calculous patient in particular, it is essential to enforce a very sparing use of fatty matters in food. If he is already stout, weighing some ten to twenty-five pounds, as often happens, more than the average attained

by healthy men of active habits, the abstinence should be strict; and the gradual reduction of his weight insured thereby will, within certain wide limits, denote the measure of his improvement in relation to his calculous tendency. In order to insure a steady but gradual diminution of bulk, the patient should always be weighed by his adviser, and the amount registered for comparison week by week, that the effects of the change in diet may be accurately observed. A loss of four or five pounds during the first month will almost invariably be attended by a sense of increased power, of agreeable disposition to activity, in the place of pre-existing torpor, lassitude, and oppression. During the second month the diminution will be less; in the third less still, by the end of which time another three or four pounds or so will be taken from the heavy burdens which have afflicted the corpulent patient. When this condition is not present, a less rigid regulation in relation to fatty matters is necessary; although in all such cases they must be permitted in very moderate quantity.

What are the ordinary foods in daily use which largely contain the objectionable elements, and must therefore be more or less avoided? Milk, cream, butter, cheese, eggs (especially in the form of omelette), creams and pastry; fat pork in its many forms; suet in puddings and pastes, the fat of roast and boiled meats, etc. The homely rice or sago pudding, chiefly compounded of milk and egg with sugar, so excellent for our children, and for healthy active people—type of simplicity; I might almost say, of the domestic virtues—is in the last degree objectionable for your uric-acid-making, gouty patient. Nevertheless, all the farinaceæ may be used so as to furnish desirable dishes in the nature of puddings, if made savory, not sweet, with light broths instead of milk, using eggs in moderation, some condiment (a pinch of curry, or a few morsels of chutney) instead of sugar. Then next all articles of food, whether natural products or artificially combined, which contain sugar, particularly cane-sugar, must be expunged absolutely from the list of aliments permitted. I do not enlarge further here on the principle on which this advice is given. There is much to be said thereon, but this is neither the time nor the place for discussing the subject at great length. Suffice it to add that abstinence from the substances named probably lightens considerably the work of the liver, and so

lessens manifold vicarious forms of activity on the part of the kidneys in accordance with the views already propounded. Let me just advert, however, to the dietetic system in force at Carlsbad in relation to the patients in question. Apparently in recognition of the principle explained above, the use of sugar and of butter is absolutely forbidden during a Carlsbad course; and were one of you a patient there, your purveyor would not supply you with the forbidden food, however much you might demand it. I can only say, as the result of observation, that this system, far more than that of eliminating meat from the dietary, will reduce the uric-acid deposit. By forbidding everything that contains sugar, and diminishing considerably all fatty matter—permitting nitrogenous food in fact, although only in moderate quantity, and diminishing greatly hydrocarbons—you will generally accomplish more than by the contrary method.

What then is the dietary to consist of? Fish in all its forms, except those which contain much fatty matter, as herrings, mackerel, eels, and the under part of the salmon. Game in all its forms and poultry; lean meat in moderate quantity, besides preparations of gelatine, often welcome and useful as savory jelly as well as that which is otherwise agreeably flavored or acidulated, but unsweetened. Butter in moderation is the only direct form of fat, some being necessary, which I am in the habit of permitting, as well as an egg or two, without which cookery is impossible, objection relating solely to the yolk or fatty part, and milk in strict moderation. Well-made bread, especially that which contains every portion of the wheat grain, outer envelope or husk included; oatmeal, pearl barley, macaroni, and the Italian pastes; all can be easily presented in numerous simple yet palatable modes, by the exercise of very little culinary intelligence, and ought to occupy a large place in the daily service of food.

In relation to whole-meal bread for daily regular use, let me pause an instant to remark that the value of inert matter as an essential part of our food seems to be quite lost sight of in the search for "nutritious and supporting" elements, unmixed if possible with any other. Even so-called "bread reformers" vaunt as an improvement their elaborate processes of ridding wheat meal of every particle of what they are pleased to regard as useless matter. Few people appear to

know that most of the habitual constipation, so generally complained of, is due solely to the fact that modern civilization demands the elimination of everything that is not nutritious from our food, the consequence being that there is very little inert substance left after digestion to produce a fæcal mass for the muscular intestine to grasp and transmit. The cereals and green vegetables, when employed in their nearly natural conditions, furnish for this very useful purpose a quantity of inert material, which a well-meant but blundering interference officiously removes. It is quite remarkable to what a large extent this important element of food is ignored, even by professed authorities on diet, unless its value be not, which is more probably true, wholly unknown and unsuspected by them. I may add that the whole-meal bread, which is on this account so valuable, may be improved, both in flavor and texture, by an admixture of fine, not coarse, Scotch oatmeal, in the proportion of one-fourth or one-third to the wheat-meal employed.

Another class of vegetable products of great importance on the ground of the nutritious elements, especially nitrogenous, which they contain, is presented by dried haricots in all their varieties and lentils. These are capable of furnishing excellent dishes, often preferred to joints of beef and mutton, which they may sometimes advantageously replace. They may also enter into the composition of soups in the form of purée, valuable for the ease with which they are usually digested and the amount of nutriment contained, especially to those whose occupation is active and demands physical exertion.

The less nutritious class, the farinaceæ, as rice, sago, tapioca, arrowroot, etc., are all useful treated in the manner above incidentally referred to, that is, as savory dishes and not as sweets. Fresh green vegetables are especially to be recommended, and are worth bestowing some pains on, to obtain good and cook well, when they may form an important item of the list. The fresh legumes, such as green peas, young broad beans, etc., are valuable for most people, although a few do not digest them easily, especially if time is not given to mastication and insalivation (absolutely essential, not only for digestion, but to secure all their nutritious elements), however tender the vegetable product may be. Some persons can

digest a light salad; others can eat no vegetable until it has been cooked; and no rule can be made applicable in all cases respecting it. Celery and seakale, asparagus and tomatoes, the potato and the artichoke, are important items on our list to which I know of no objection, although the potato has been often, as I think unnecessarily, excluded from it. Apples may generally be permitted, best when roasted or baked, without added sugar; but rhubarb, strawberries, raspberries, gooseberries and currants, grapes, plums, pears, and all sweet fruit, native or foreign, must be rejected without hesitation, whether fresh or preserved. For those persons who feel the loss of sugar in diet, as that of a luxury highly prized, and there are many who do so, no objection can be made to the use of the recently discovered product "saccharin." It exerts no action in the body akin to that of cane and grape sugars, and appears to be quite harmless in every respect.

Milk, already referred to, is very undesirable as an article of diet, both on account of the large proportion of fat and sugar it contains; while its nitrogenous principle, casein, is by no means a universally digestible element. At the same time a small quantity, to be taken with tea, coffee, or cocoa, not in the proportion usually adopted for "café au lait," may be taken without hesitation of course. In large quantity it is not only noxious, but is often digested with great difficulty by the class of patients now under consideration. Thoroughly skimmed it is less objectionable, although the remaining elements render caution in the matter of quantity still desirable. In the same way, there is no objection to the use of the white of egg, so valuable in cookery; the yolk being, from the large proportion of its oily constituent, the part which should be eliminated or employed with great moderation.

Here, I think, is a range for choice by no means to be complained of, at all events for a class of patients whose dietary must, in some important particulars, be strictly curtailed. Modifications can and should be made by minimizing or augmenting the relative proportion of animal and vegetable elements according to the engagements, surroundings, or idiosyncrasies of the individual.

I next remind you after this brief, but still sufficient sketch of the principles of the dietary, that other points of hygiene must be attended to, when conformity to the first and chief

has been insured. Thus it is essential to stipulate for a certain amount of muscular exercise, some to be taken in the fresh air daily. Quite as important is attention to the healthy action of the skin, encouraging this by a habit of simple daily bathing in the bedroom, following it by friction of the surface of the body in some efficient manner.

But the first-named object as well as the second may to some extent be accomplished by the same process, and by no better mode than by the systematic use of the flesh brush. I have long recommended for this purpose a brush specially made with rather soft bristles of unequal lengths, so as not to present an even flatly cut surface, which latter effects the object imperfectly. The soft uneven bristles gently penetrate between folds and flexures, or follow the varied contours of the body, without irritating, much less abrading the skin. A pair of these, each with its strap passing over either hand of the user, systematically applied for five or ten minutes every morning, afford a capital form of exercise for those who have little opportunity of obtaining it sufficiently out of doors, and so for the middle-aged and elderly man offer an equivalent to the club or dumb-bell performance of the young and hearty.

At this period of life the capillary circulation of the skin mostly becomes languid and deficient, if not stimulated or provided for by some special means. Hence it is that unnatural dryness of the skin, harshness, chronic eruption, coldness or partial insensibility of the surface are so often experienced by elderly people. By daily gentle applications of the soft brush, circulation of the blood in the superficial capillaries is produced, and a skin which has long been dry, rough, and inactive may in a few weeks be rendered soft, supple, and vascular, like that of a healthy person in middle life. Better still, such a skin performs its functions and takes its share of work among the other eliminating organs of the body.

It should not be forgotten that with the diet described, some increase of clothing is usually necessary. There is no doubt that thicker coverings in spring and winter are felt to be necessary now, than when food more rich in fat was freely consumed. On the other hand it is a marked and agreeable experience for many, that the oppressive heat and the plague of thirst which so many complain of in hot summer weather are unknown to the consumer of diet which is chiefly cereal

and vegetable, with some fish and a little fruit. These matters are here named, being of essential importance, from their necessary and close relation to the subject of food and its functions.

Such, then, is an outline of the system embracing a regulated diet, regimen, and the use of natural mineral waters, which I have so long and so satisfactorily employed, and which I strongly advise you to pursue for the purpose of checking calculous disease in its early stages, and so preventing the formation of stone in the bladder in that considerable majority of cases which are occasioned by an undue formation of uric acid. I shall only add that I invariably advise it in a more or less modified form, but the dietary invariably, for all patients for whom I have once operated on for an acid calculus, in the hope of preventing the recurrence of any further product in the future. Nothing is more probable in a robust man of middle age who has once furnished such a product than the appearance of others in course of time. And you may wisely tell him this; but you may confidently add that if he will follow your directions, implicitly and not half-heartedly, you can very nearly promise him a future immunity from stone as the consequence.

LECTURE III.

ON THE TREATMENT OF STONE IN THE BLADDER BY SOLVENTS: ITS HISTORY AND PRACTICE.

GENTLEMEN: The inquiry as to whether it be possible by the use of medicinal or chemical agents to dissolve stone in the bladder, and so to avoid any operative proceeding for its removal, is one which has excited a great amount of interest at different epochs of our history. During many centuries this question has appeared and reappeared. Some accident calls public attention to it; interest is aroused, experimental trials of some new agent, which probably proves to be an old one in modern guise, are made, achieving little or no success; after which a cycle of indifference follows. Meantime, as the sum of these reiterated efforts, some sort of progress results. Nevertheless the subject is scarcely considered in standard surgical works, although it is one fraught with interest to us all. For myself, I confess, it has always had a degree of fascination. It would be so great a triumph to our art to dissolve the stone without damage to the delicate structures in which it arises and finds its residence. And thus it is that I have not only alluded to it in various works, but have discussed it at considerable length many years ago in one of them.

I propose, therefore, to tell you what has been done, and what at present, indeed, how little, appears to be attainable by the agents employed; endeavoring to sketch the history of solvents for stone in the bladder from the earliest period to the present day.

You know that the existence of calculus was recognized, and that a cutting operation for its removal, at all events in the cases of boys, was practiced, a few centuries before the Christian era. In course of time the attempt was made to dissolve it, especially in the case of adults. It appears that

neither Hippocrates nor Galen entertained the belief that this was possible. One of the earliest allusions to the practice is found in Pliny, who says that "the ashes of burned snails' shells are good for expelling the stone." Aretæus, in the second century of our era, recommends "quicklime in honeyed water" for the same purpose. Later authors, quoted by Paulus Ægineta (seventh century), speak confidently of the efficacy of goat's blood, and they observe that certain solvent remedies if administered to inappropriate cases may increase the size of the calculus.

Arriving at the period when medicine flourished in Arabia, we find numerous specifics and some extraordinary combinations of them systematically given. The celebrated Avicenna (about the tenth century) enumerates many substances supposed to be efficacious. He and others of his time employed occasionally an impure carbonate of potash; but as an example of the kind of prescription current at this period, I give you one of them in full, translated from Avicenna, as it is a curiosity, and gives you a good idea of the very complicated mixture which sometimes constituted an ancient medicine: "Take equal parts of calcined glass, of the ashes of scorpions, of the ashes of the root of colewort, of the ashes of a hare, of the ashes of egg-shells from which the chickens have escaped, of the stones found in the sponge, of goat's blood dried and powdered, of lapidis judaici, the same of parsley, wild carrots, marshmallow seeds, and gum arabic. Make it into an electuary with honey."[1]

Between this period and the fifteenth century we can mark no advance. About this time Basilius recommended the internal use of an alkaline salt, obtained from the cuttings of the vine in spring; this rests on the authority of Boerhaave.[2] Crollius, in his "Basilica Chymica" (Frankfort, 1608), recommended the patient to take a salt of tartar (carbonate of potash) in an infusion of parsley, and also some solutions of which lime was the principal ingredient. In 1650 Daniel Sennertus directs the internal use of the same remedies, and also that they should be injected into the bladder through a catheter. About the same time, Riverius, physician to the French Court, advises, as many others also did, the ashes of calcined egg-shells. The dose was a drachm of the powder, which was, of course, chiefly lime, to be given in white wine or

with diluents twice a day; and it is stated that "potenter expellit calculum in urinæ meatibus hærentem."[3] Numerous other authorities might be quoted as repeating all these receipts with little or no variation.

Next in order comes, in this country, the famous Mrs. Joanna Stephens. This lady had acquired so great a reputation in the earlier part of the last century, that in 1739 the English Parliament, after a formal inquiry, purchased her secret for dissolving the stone at the cost of £5,000—a circumstance which produced a large and remarkable literature during the next few years, and gave a great stimulus to research. The document which was obtained at this cost commences thus:—

"My medicines are a powder, a decoction, and pills. The powder consists of egg-shells and snails, both calcined. The decoction is made by boiling some herbs (together with a ball which consists of soap, swine's cresses burnt to blackness, and honey) in water. The pills consist of snails calcined, wild carrot seeds, burdock seeds, ashen keyes, hips and hawes, all burnt to blackness, soap, and honey."[4]

The quantity given was a drachm of the powder three times a day, mixed in cider or other liquor, and followed by half a pint of the docoction. If the decoction disagreed with the stomach, the pills were to be substituted. These compounds were found to be very nauseous, and were soon superseded by other agents.

After this, Dr. Whytt, Professor of Medicine in the University of Edinburgh (1761), brought soap and lime-water into favor, giving one ounce of "Alicant soap" and three pints of lime-water daily, and illustrating its use by a remarkable case or two.

In the practice of Blackrie (1766), Chittick (who made all his patients send locked cans of veal broth daily to his house that he might add the solvent and preserve his secret) and others, mixed solutions of potash and lime were much employed; and a considerable amount of evidence of their utility to allay pain was published on good authority. Soap lyes of different strengths furnished the potash in many cases; in others the "salt" of tartar was given, and always in a very diluted form.

In France at an early date alkaline remedies had many

advocates, such as Darcet (1726)[5] and Pierre Desault (1736). Morand, the famous surgeon of Paris, who came to London to report to the French Academy on Cheselden's operation of lithotomy, made also very careful observations on forty patients treated by Mrs. Stephen's remedies. He was unable to certify to a single case of removal by the solvent, but said that four "thought themselves cured." Much later, the subject of alkaline solvents was investigated by Fourcroy and Vauquelin; more recently by C. Petit (1834). The first and last named employed the Vichy waters. In Italy, Girardi (1764) recommended the use of solvents, but extolled especially the virtues of a decoction of uva ursi for that purpose.

Meantime the vegetable kingdom had been largely explored for the same purpose. It will suffice to give a list of a few of the principal plants so employed during the last two or three centuries. I shall name those only which enjoyed the greatest favor. The "Banke cress," or "saxifrage" (the name being due to its reputed virtue); its seeds boiled in decoction of couch grass; dose of the seeds, one drachm. Tincture of the "Pimpinella saxifraga." A tincture of the seeds of the "Lithospermum majus," or "great gromell." The decoction of "Broome;" a tincture of the seeds of "Fraxinella." Tincture of the root of the "Raphanus sativus," or garden radish. Tincture of the seeds of the common nettle. The marsh and yellow mallows, the couch grass, parsley, and the wild carrot were also ingredients in the compound decoctions employed.

And now I come to the experience of to-day. And I suppose you to inquire, "What are the existing resources available for a patient who desires at the present time to attempt the solution of a stone in his bladder?"

I shall divide these into two classes. First, there are the empirical remedies, which have a certain reputation; and secondly, there is the result of the latest investigation of the subject by scientific observers.

First, the empirical remedies. It is a curious fact that in almost every European country there exist certain persons who obtain a livelihood by making and selling remedies to dissolve the stone. The recipes employed are usually family heirlooms, and a sort of reputation clings to the family, each generation of which carefully preserves the secret, such as it is, and the traditions of their predecessors. In the same way

what is called the art of bone-setting, as you no doubt know, is associated with certain names and localities; known chiefly in provincial districts, where also flourish the makers of the nostrums now in question. The liquid solvents—for they usually take that form—are sold in this country under the name of "constitution water," or some similar term; and as a matter of course they are also guaranteed to be useful in all forms of urinary disease.

Peculiar circumstances have given me large opportunities of observing and examining these agents. I have met with them here and in different parts of France. I well remember an old Frenchwoman and her son journeying on foot from the South of France to Brussels, many years ago, laden with a basket of heavy bottles filled with the family nostrum for presentation to a royal patient there. (The first King Leopold of Belgium, who suffered severely from calculus, and whose case excited much interest at the time.) I may add that her devotion was substantially rewarded. Such unsolicited contributions—either material, as in this case, or by way of suggestion of every conceivable kind—flowed in then from every part of Europe; and such is always the case in similar circumstances.

Let me say that it has been my lot to receive numerous communications on this subject from known and unknown correspondents, urging on me the value of the recipes which belong to the writers. I shall select two examples, which widely differ, for mention here, each possessing interest of its own kind. One was from a French gentleman, who gives me his name, and offers an infallible cure for the stone, which of course he does not describe, but consents to communicate it for the moderate sum of a million of francs (£40,000 sterling); and I do not hesitate to say it would be well worth the cost if it could accomplish the wonderful results alleged to be within its power. The other communication was sent me by an English laborer in Bedfordshire, who wishes me to know what cured his friend some time ago in the neighboring parish. He freely presents me with the formula, and it is a fair specimen of a good country recipe for the purpose—for I have seen many such—and it has some interest for us, as we shall find hereafter. I could not help writing my thanks to this man in reply, and was at some trouble to explain why his remedy

might be good in some cases, and why it might be prejudicial in others. Here it is in his own words: "Get a peck of wood-ashes, and pour on them a gallon of boiling water; let it stand twenty-four hours: then strain it off as clear as possible, and take a wineglassful every morning, fasting." This is a large dose of carbonate of potash: our old friend, the alkali, you see, always recurring. I had the curiosity to determine the quantity. A lye of wood-ashes thus made from pine-wood furnishes a solution of fifty grains of the carbonate to the ounce, so that the quantity taken at once was at least a drachm and a half or two drachms. The other soluble constituents of the lye are sulphate and silicate of potash and chloride of potassium.

Now, as to the more pretentious compounds which are sold in this country as solvents, I have submitted the chief to careful chemical analysis, and I intend to present you with the result. Not that I had any doubt as to what their general characters and composition were, nor of the fact that they were all nearly alike in their composition. But I wish you to have an exact statement founded on analysis. A recent examination of a well-known and typical one sold as "constitution water," and in some repute in this country, shows it to consist of a simple undisguised solution of bicarbonate of potash in water. Two bottles are placed before you, and are at your service for analysis if you like to make it. You see that they are ordinary wine-bottles, the old "wine-quart;" each contains about an ounce of bicarbonate of potash and fifteen grains of chloride of sodium—with a few sulphates in minute quantity, possibly due to the spring water of which evidently the solution is made. Half the bottle, which is equivalent to four drachms, is directed to be taken daily. The price at which this "constitution water" is sold is three shillings and sixpence the bottle!

And here let us make a rapid survey of the long and curious history of man's painful, slow, and somewhat clumsy efforts to rid himself by medicine of his terrible enemy, the stone. Observe that the agents have always been alkaline. At first, and chiefly, the alkaline earth, lime: you mark it as the agent in the calcined snail-shells of Pliny and the egg-shells of Avicenna, which do but reappear in that expensive prescription of Mrs. Stephens in 1739; but in Avicenna's time it was combined with potash, the representative alkali of the

vegetable kingdom, as you see in the quantity of burned plants which enter into the composition; and Mrs. Stephens, probably without knowing it, employed potash and soda also, by means of the very important addition of soap, calcined weeds and seeds to the egg-shells. After this lime-water and soap came into fashion, giving another combination of the three alkaline agents named. And the popular remedy of to-day before you, sold at so high a price to the purchaser, and of which a large quantity is ordered to be taken daily for three months, as the minimum dose and time, is, as you have just seen, a simple solution of bicarbonate of potash in water; and the cost of it to the seller is actually less than that of the bottle and the cork which enclose it! Our country laborer's nostrum is nearly if not quite as good in form, has precisely the same solvent power, and is almost absolutely without cost.

Then the alkali again appears in a group of natural mineral springs, of which a somewhat popular remedy—namely, Vichy water—is the type. These have been and still are largely employed by patients with urinary maladies, and have been vaunted for their solvent powers on the ground that they consist mainly of a strong solution of carbonate of soda, the alkali of the mineral kingdom, as potash is of the vegetable

We are now in a position to arrive at the following conclusion, the only one possible—viz. that all the empirical and would-be secret medicines employed from time immemorial to the present day are solutions of either lime, soda, or potash, alone or combined. All the plants, after combustion, furnish alike only one and the same active agent—viz. potash; all shells, whether of eggs or of marine and land animals, furnish alike only one and the same active agent—viz. lime.

Lastly, the medicinal remedies employed by the faculty everywhere, at the present day, are hydrate of potash, in the form of liquor potassæ, the bicarbonate, the citrate, the acetate, and the tartrate of potash. After them, and less generally employed, are soda and lithia in different forms.

Now, before entering on any consideration of the applicability of all these agents as solvents, from a scientific and not from an empirical point of view, it is necessary to examine briefly the substances they are destined to act upon—namely, the stones in the kidney or the bladder which it is desired to dissolve. And the first fact that must strike you at the out-

set is, that these calculi are of different kinds; some having characters diametrically opposite to those of another kind. And the question naturally arises, Is it possible that one form of remedy—namely, the alkaline agent—can be adapted to dissolve calculi whose composition is so varied?

I shall remind you of those general terms which I used in a recent lecture on that subject to classify the varieties of urinary calculi. Three-fifths of all the calculi met with among adults of all ages are composed of uric acid and the urates; nearly two-fifths are chiefly phosphatic, many of which are "mixed"—that is, contain at least two different constituents; and about 3 or 4 per cent. are oxalate of lime. Cystine is too rare to be admitted to our reckoning. Three-fifths at least, then, are the products of a urine abounding in acid, of which excess they are the expression. The remaining two-fifths are the product of urine generally alkaline, mostly ammoniacal, of which condition they are the result. The urates, the oxalates, and a very few of the phosphates, are formed in the kidney, and are the product of certain constitutional derangements; the greater part of the phosphatic material, whether in mixed or in phosphatic stones, is produced solely in the bladder, and is the product, not of a constitutional state, but of local disease there. Now, uric acid we know, by experiments conducted out of the body, to be soluble in alkaline solutions, but some of these have a more energetic solvent action than others; and the resulting salts vary in solubility. Thus, urate of lime is a rather soluble salt. Urate of soda is less so, and in this form enters into the composition of some calculi. Urate of potash is more soluble than either of them. Potash, the alkali of the vegetable kingdom, appears to be the most powerful solvent (although lithia may be nearly equal) that can be employed on a uric-acid calculus, among those materials which are capable of being taken internally for a long period of time with comparative impunity. These facts, then, indicate it as the most desirable agent to employ under certain conditions, hereafter to be described, and as such it has long been regarded. More than thirty years ago I called attention to its pre-eminence for this purpose, stating that the "citrates and carbonates of potash are more potent and certain than Vichy water" for the treatment of "uric acid in the form of gravel," and that they should be given largely diluted, pure

water itself being one of the best solvents.[6] I may add, that I have always declined to prescribe Vichy water for any urinary affection, and on the ground of its inferiority to the potash solutions. I think the citrate of potash may be fairly said to be the salt which of all others offers the best chance of success; and this is now the opinion of all who have examined the subject. If, however, it exerts too much diuretic action, as in some cases it seems to do, the next best may be employed—namely, the bicarbonate, or the liquor potassæ.

A question of great interest comes before us here. Has citrate of potash been fairly tried on stone in the bladder by a competent observer? I am happy in being able to answer this question in the affirmative. A well-known and accomplished physician, Sir William Roberts, of Manchester, formerly a distinguished pupil of this school, has made carefully conducted experiments on calculi in and out of the bladder with certain results. I give you the following brief analysis of them:

Sir William Roberts finds carbonate of potash to be the most powerful solvent; better than soda, much better than lithia. The solution must not be too strong, otherwise an alkaline biurate coats the calculus and solution is checked. The best salts to administer by mouth are the citrate and the acetate, these, as you know, becoming carbonates in the urine. The adult dose should be forty or fifty grains in three or four ounces of water every three hours—equalling six drachms daily. The urine thus rendered alkaline may become cloudy from amorphous phosphates, but this state does not hinder solution, provided the urine is not also ammoniacal; but if it becomes so, it is most important to bear in mind that all solvent action then absolutely ceases. Hence it is useless to attempt the solution of a uric-acid stone unless the urine is naturally acid. If the urine is alkaline before commencement it is certainly ammoniacal, and no solvent will act, as mixed phosphates are deposited on the surface of the stone. He admits that it is quite useless to attempt the solution of a large calculus of any kind, or of an oxalate of lime calculus; and that nothing can be done with a phosphatic calculus except by the process of injecting into the bladder. Lastly, he states, alkaline injections of the bladder for uric-acid calculus are without efficacy. To resume: the following conditions are essential to success: certainty that the stone is of uric acid,

and that it is of small size; that the urine is acid, and never ammoniacal. These extremely favorable conditions existing, the most powerful solvent known—potash—offers a fair chance of diminishing its volume considerably after a trial of several weeks, so that the nucleus may perhaps be passed by the urethra; but at present Sir William Roberts is not able to report so complete a success.[7]

There, that is the best thing that modern science has yet done towards accomplishing the dissolution of the stone. Then you say, Have there been no results whatever from the empirical methods you have described? Have miserable calculous patients for two thousand years been swallowing to no purpose all the nauseous mixtures described, from the time of Pliny to Joanna Stephens, and onwards through Chittick, with his locked cans, to the nostrum dealers of our own time? I wish to give you a fair and distinct answer to that question, and will do so as far as it is in my power.

I reply, first, that no trustworthy evidence has yet been produced, that the complete solution of a stone in the bladder has been effected by any alkaline agent whatever. I cannot find that any patient, certified to have stone after sounding by a competent surgeon, has, after a course of any solvent, been again sounded, or submitted to autopsy, and demonstrated to be free from stone. Less evidence than this is valueless. That the alkaline solutions often greatly palliate severe symptoms in some cases and enable some patients, but by no means all, to continue in comparative comfort for a considerable time without extraction by any method, I have long been perfectly satisfied. I have seen a remarkable example or two of their influence among those aged and very infirm persons whom it would be very dangerous to submit at any rate to lateral lithotomy, and whose calculi are not within the limits of lithotrity. Such have sometimes been enabled to spend the remainder of their lives with little or no suffering, provided that they were also enabled to maintain a condition of repose and freedom from movement. More commonly, however, the freedom from pain which alkaline agents produce is temporary only; and in some cases the effect of them is to produce considerable aggravation of the symptoms. This was often observed during the "soap and lime-water" period. But it is not the question now to estimate what degree of palliative

influence is exerted by alkalies, but whether they can effect a complete solution of the stone. Morand's cases, already referred to, of which twenty-two were sounded before taking the medicine, did not supply a single proved example of success. Among the alleged triumphs of the lime and potash treatment, many patients were examined after death and found to have stones, often numerous and large, still in the bladder. (Dr. James Parsons reports twelve post-mortems of Mrs. Stephens's patients, who, dying, were found in that condition.)[8] But what is more to the point is, that the four persons who were examined by the trustees appointed by the Government to determine the merits of Mrs. Stephens's remedies, and certified to be cured, died, each one of them with stone in the bladder, where it was found by post-mortem examination! (The names of these patients were Gardiner, Appleton, Norris, and Brighty.)[9]

The case of Horace Walpole in the last century is well known; it was written by himself for the Royal Society. He commenced—being nearly seventy years of age—to take from half an ounce to an ounce of Alicant soap and three pints of lime-water daily for many months at a time, and with short intervals, up to the period of his death at seventy-eight. He experienced great relief after taking them for a year or so, and ultimately believed himself to be cured. At his death three smallish calculi were found in his bladder. The case naturally attracted much interest at the time, and is one of the most carefully observed on record.

But there is another curious fact in connection with this matter, namely, that the great majority of the patients who took these medicines then, and of those who take such now, are not the subjects of stone at all. They have painful symptoms which they are pleased to consider evidence of stone in the bladder, and they take large doses of alkali—notoriously one of the best remedies for painful micturition from any cause —and obtain relief. They then tell their neighbors, and often certify in print, that they "have been cured of that dangerous malady the stone." These are the great cures which the nostrum-mongers rely upon. For what happens to those few of their clients who really have stone? Two things may happen: first, the stone, if uric acid, becomes coated, as Sir William Roberts describes, with the biurate, which either adheres or

comes away in scales; or, secondly, the urine will become ammoniacal; and thus in either case no dissolution whatever can occur. During the time, however, large quantities of white sediment composed of the earthy phosphates or even of shell-like fragments of the biurate, to say nothing of the white granular deposit of the mixed phosphates, come away; all which the poor patient is led to believe to be the débris of his stone and the proof of the efficacy of the solvent process! This fact exists in the great majority of cases, and is always relied upon by the nostrum vendor as an infallible sign of the value of the agent! Meantime the stone is acquiring, not slowly, fresh layers of deposit, and is becoming almost certainly larger. Such must often be the inevitable result where the medicines are empirically given—that is, without reference to the nature of the stone and the condition of the urine, and where the procedure cannot be watched and regulated on the principles laid down above. But, say you, this is a mere *à priori* statement, and looks very plausible, no doubt; but how do you know that this happens? I will give you two instances which will suffice, and can give more, if required. Several years ago a man came to me from Yorkshire, who, having had symptoms of stone for a considerable time, was advised to take some well-known solvent for his malady. Accordingly he did so, and you will agree with me probably that he took enough to insure it a fair trial, for he swallowed twenty-five pounds' worth of that very constitution water a sample of which you see before you on the table. He was relieved, but his life was necessarily an active one, and he had not the means of repose and the luxurious surroundings which Horace Walpole had, and his stone symptoms ultimately got worse. At last he came to me, and I crushed for him a large mixed calculus, the greater portion of which was phosphatic. Had he come to me before, it would have been a smaller one. The case did well, and the man lives at this day to tell the tale, and, if necessary, he is ready to tell it again. Since that time I have seen more painful illustrations of the mischief done by this nostrum; one case especially, within the last few months, in which death was due to a large phosphatic stone produced through the action of the alkali taken. It was formed upon a small uric-acid calculus, which could have been crushed with ease and safety in three minutes when I first detected it, and recommended that course. But

the patient preferred the "solvent," and in about two years filled his bladder with a phosphatic mass which cost him his life.

Now, mind, I do not venture to say that a calculus has never been dissolved, or that it is impossible to dissolve a small uric-acid calculus by alkaline agents taken internally. I will go further, and express my belief that, given abundance of time and careful supervision, it may perhaps be possible. Nay, I will do more: the first case of such a kind that comes into the hospital, the patient consenting, I shall be pleased to submit him for the sake of experiment to the process, and to give it a fair trial. But this I say with certainty, that there is no evidence whatever that one case in a thousand of those who have swallowed solvents for the stone has been cured of it, during all past experience down to this day. No man who deliberately takes solvents for even a small calculus, the characters of which have not been carefully determined, can reckon on any better chance than this—viz. that it is a hundred to one against their success, and that it is more than probable that his stone will grow bigger during the process. And if the stone be large, the solution is impossible.

What is the value of the treatment in question? It is impossible to say more than that it may be valuable, not for stone in the bladder, but for that earlier stage of the same malady—stone in the kidney. That is the period of its history in which to attack the stone by solvents. When small uric-acid calculi are passing periodically or occasionally, much may be done: first, and chiefly, by preventive treatment, on principles I have already explained to you in the preceding lectures devoted to that subject; and if that be insufficient alone, secondly, by combining perhaps therewith some alkaline treatment. Granted proper constitutional treatment of the complaint in the early stage, there ought rarely to be much trouble with stone in the bladder. I confidently anticipate a future in which any severe operation for stone will be rare. Uric-acid stones only, as you know, are amenable to the process by solution; but happily, they form the very large majority of renal calculi.

I must say a few words about agents to be used locally in the bladder for the solution of phosphatic formations which are not dissolved, but rather increased, by the internal remedies

already described. You know that there are many patients, chiefly those who are unable to empty the bladder except by catheter, who are very prone to form calculous matter of the mixed phosphates, and this sometimes at a rapid rate. For these persons various solutions injected into the bladder may be valuable. The patient may be taught to administer them himself; numbers have beeen taught in my wards. Once or twice a day, after withdrawing all the urine by catheter, he applies to the end of it a four-ounce bottle, with a stopcock, containing a solution of acetate of lead, about one-third or one-half a grain to the ounce of distilled water together with some acetic acid. He throws in half the contents, and allows it to issue, carrying out with it some small débris perhaps. He next injects the second half, and allows it to remain there. This does something to prevent the formation of phosphatic calculus, or, at all events, of the aggregation of its elements in the bladder. I have no intention to describe now at length the methods of mechanically dissolving or washing out these matters, when the above simple means are unsuccessful. More complete details in reference to this subject will be found in its proper place.

I must not omit to name the agency of electricity, which has also been locally employed, both for uric-acid and for phosphatic stones. Prévost and Dumas (1823) attempted direct solution of a stone in the bladder by the galvanic current, a plan which was more fully developed here by Dr. Bence Jones (1852). The amount of instrumental manipulation, however, necessary to bring the wires into contact with the stone and to maintain them there during the period necessary for its solution is considerably greater than that required to crush the stone by the modern method of lithotrity, and must therefore be regarded at present as inapplicable.

And now comes the inevitable final conclusion—inevitable because true. It has been shown that there is no chance for the dissolution of any but a small stone, and this provided only that it exists in the most favorable circumstances; and lastly, that in order to accomplish the task a considerable period of time must be devoted to the process.

For such a stone, gentlemen, but one brief sitting by lithotrity is necessary. No operation in the whole range of surgery is more certainly safe, rapid, and successful; and no

other proceeding ought to be resorted to or even considered. I repeat the statement, that such a case I have never lost in the whole course of my experience. Nevertheless, a patient sometimes desires to be heard in relation to the course proposed, although he may be absolutely ignorant of the matter. He claims the right to exercise a choice, although he may not always manifest his wisdom in doing so. In these circumstances it becomes our duty to help him to form a just estimate of the relative merits of both methods; what these are I have thus endeavored impartially to set before you.

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SPRAINS AND THEIR CONSEQUENCES.

INTRODUCTION.

It has been my endeavor in the following pages to confine myself as closely as possible to the commoner forms of sprains, and to those after consequences which may be regarded as directly and immediately dependent on them. Of those which follow more remotely there is no end, and the briefest description would lead me far beyond the limits at my disposal. It has been said, and not untruly, that in all probability half the crippled limbs and stiffened joints that are met with every day, date their starting point from the occurrence of some apparently trivial accident of this description.

The question of treatment has been dealt with at some length; and if I have seemed to advocate the adoption of more active measures than those generally employed, especially in the case of long standing inability, it is only that I am firmly convinced of their efficacy and safety when properly carried out.

Few injuries are treated with so little consideration as sprains. It is impossible to overlook wounds, owing to the bleeding and pain that accompany them. Fractures, it is understood, require rest and care; but sprains, in which the tissues are torn to such a degree that the damage is far more serious than in many fractures, merely because they are so common, are considered of little or no consequence.

It counts for nothing that the part injured is one of the most complicated structures in the body, and particularly liable to inflammation from the constant use to which it is subjected. The construction of a bone is comparatively simple, and its function is merely the passive duty of support. A

joint, on the other hand, is exceedingly complex, and must not only be as strong for support as the bones between which it lies, but must, in addition, be capable of executing rapid and often extensive movements. Two, three, or even more bones may enter into its construction; each of them where it forms part of the joint is faced with cartilage; around them is a protecting capsule of fibrous tissue, lined with a delicate secreting membrane; ligaments of different kinds hold the bones together; muscles of various size and strength move them one on the other; there is a very large supply of blood-vessels and nerves; and even the tissues round are so adjusted to the surfaces that with every change in position they fill up the constantly-varying spaces round and between the bones. Yet a fracture is regarded as very serious; a sprained joint as quite a trivial matter.

In the one the injury is simple and definite in its character; one broken bone does not differ very materially in this respect from another; in the other there is no limit to the variety of hurt sustained, or to the complications that follow. The ligaments may be torn across, or wrenched off the bone; the muscles may be lacerated; the tendons displaced bodily from their grooves; the discs of cartilage which are present in some joints between the bones, forced out from their position; the joint cavity filled with blood, and so much more extravasated into the tissues that the discoloration may reach from the ankle to the knee; in short, the tissues may be torn and bruised as extensively as in a dislocation. In many cases the injury is to all intents and purposes the same; the sole difference is that the bones which were wrenched apart at the time of the accident resume their normal relation to each other in the one, while in the other they either remain fixed, or slip a little further aside. Vidal de Cassis appreciated this when he spoke of sprains as temporary dislocations.

There is no end to the variety of the injuries that are classed together under this name. It is almost an impossibility for two sprains to be exactly alike. Joints differ from each other as widely as they can, both in structure and action; different kinds of tissue enter into their formation, and serve as many separate purposes; the violence that causes the accident is different in every case, both in its force and direction; and the position of the limb at the moment can rarely be the

same. Some joints are much more liable to injury than others, those especially in the lower limb; and the ankle more than the hip or knee. In some the stress falls on the ligaments; in others, as in the shoulder, on the muscles; very often both suffer together, though in varying proportion; or without the joint itself being injured, the muscles and tendons may be strained, and give rise to stiffness or weakness that lasts for years.

Other considerations also step in and help to make the variety greater. No two persons ever resemble each other exactly; even if this were possible in the earliest years of life, age, habits, occupation, mental temperament, bodily constitution, and many other things, induce such modifications that the slightest difference must at length become immense. Repair is not carried on with the same degree of energy in all; in some complications occur much more easily than they do in others; inflammation breaks out more readily, or other troubles make their appearance; so that, even if by some strange chance the injuries were identically the same in any two cases, it is impossible for them to continue so for any length of time. In this respect peculiarities of constitution are of great significance; in the majority of instances the ultimate result, whether the joint recovers within a reasonable period, or remains cold, stiff, and untrustworthy for years, depends much more on them, and on the method of treatment adopted, than on the mere fact of a ligament having been torn or only stretched.

This, however, is not the only reason why sprains do not merit the neglect with which they are so often treated. Imperfect recovery in the case of a broken bone is quite exceptional. Failure of union does sometimes, but very rarely, occur. It is more common for the position of the broken ends to be faulty, so that there is some deformity, or loss of power; but even when this does happen the after-trouble or inconvenience is only of a temporary character, and at the end of a few weeks or months, at the most, the limb is as strong and firm as ever. Such a thing as yielding, weakness, or continued pain at the seat of fracture is almost unknown, unless there is some exceptional condition of things present. It is not so with sprains. An amount of the thickening round the seat of injury, so slight as altogether to escape notice in the case of a fracture, is quite enough to disable a joint.

It is true that a large number of sprained joints get well of themselves, or under ordinary domestic treatment, a few, it must be admitted, in spite of it; but even in the young and healthy, it is not unusual to find the action of the joint seriously impaired. There may be merely a general sense of weakness and insecurity, a feeling that it is not to be trusted as it was before; or the least attempt at movement may be attended with intolerable suffering. There may be no very visible or definite alteration, or every tissue of which the joint is composed may be more or less disorganized. The skin may be exquisitely tender; the subcutaneous tissues swollen and distended, so that the natural outline cannot even be recognized; the muscles may waste away; the tendons become glued to their sheaths, and the interior of the joint be damaged to such an extent that, even if everything else were restored, it would be impossible for the bone to work evenly or smoothly on the other.

Results of this kind, happily, may nearly always be prevented. It is true that in some people the power of repair is much more feeble than it is in others; and, no doubt, under some conditions, such as advancing age, joints are especially prone to stiffness and other troubles; but taking them as a whole, few kinds of accidents are more amenable to treatment than sprains, if only two conditions are observed: one, that it is commenced sufficiently early; the other, that it is carried out thoroughly and efficiently, not in a perfunctory manner.

Afterwards, if the time immediately after the accident has been allowed to pass by, and the joint is stiff, and recovery imperfect, a great deal may still be done; but as a rule, the longer the delay the more remote the prospect of perfect restoration. The sudden and startling cures that are so often heard of are really few and far between. It must always be remembered that in surgery, as in most other things, successes are trumpeted abroad, and always quoted as an encouragement, while failures are either never heard of, or quite unconsciously are forgotten. Much more often recovery is slow and tedious, requiring care and much patience, with days in which improvement is well marked, interspersed among a much larger number on which either no change at all is apparent, or possibly even the pain and stiffness seem actually worse.

CHAPTER I.

THE ANATOMY OF JOINTS.

THERE is no need in a work of this kind to enter into a detailed account of the structure of joints, or to describe minutely the different varieties. I shall only mention a few particulars to which it seems advisable to call attention, as the clinical symptoms that follow injuries do not always correspond with the structures as described in ordinary anatomical treatises.

A joint is the connecting link between two of the rigid parts of the skeleton. Both in the trunk and in the limbs the main support runs down the centre like an axis, and for the sake of mobility is divided into rigid and flexible segments. The latter are known as joints.

Yielding Joints.—Some are very simple. There is merely a tough layer, made up partly of fibrous tissue, and partly of cartilage, uniting the two bones, and allowing a limited amount of bending to take place between them in all directions. Bone and fibro-cartilage are developed from the same material; in one part lime salts are deposited, so that it becomes hard and dense; in another fibres make their appearance, and it is converted into ligamentous tissue, capable of bending with ease from side to side, but admirably adapted to resist longitudinal strain. The two are quite continuous, and shade off imperceptibly into each other. So slight, indeed, is the difference, that it not unfrequently happens, as a result of disease, or even of old age, that the whole becomes converted into bone, and the joint disappears as such.

Others are a little more complicated; but the changes that make their appearance during normal growth, or at certain special periods, show plainly that the difference between them and the more complex ones is only one of degree, and not one of kind. The ends of the bones, if carefully examined, are a little expanded, so as to form a wider surface for the attachment of the uniting disc; while the sides are cut away to lessen

the weight and to economize material. At the same time the softer intermediate part becomes modified. Owing to the varied character of the strains that fall on its sides and centre, they become different in texture and in power of resistance. The centre, where, whatever the direction in which one bone is bent on the other, there must always be pressure with but little tendency to separation, remains cellular, or becomes so soft and yielding that in some cases it is almost fluid. At the circumference, where in every strain there is compression on the concave side and tension on the convex, the connecting medium gradually becomes more and more fibrous, until by degrees the originally uniform layer of fibro-cartilage is resolved into a central cavity surrounded by a fibrous capsule and separated from the surfaces of the bones by a layer of cartilage which undergoes no alteration.

Such are the joints in the backbone between the bodies of the vertebræ, though in them, at least in man, the change rarely progresses so far. The union is exceedingly strong; the amount of movement allowed at each very limited, though it may take place in any direction; and the aggregate result of a number close together is very considerable.

They are very rarely sprained; their strength, their position close together, so that any stress falling on one is distributed over a large number, and the limited range of movement, prove their safeguard. If the violence is so extreme that something must give way, they either tear across or separate from the bone on one side. Then the injury is to all intents and purposes a fracture, and like fractures is repaired by the deposition of bony material, so that the joint is lost.

Movable Joints.—It is only a step from joints such as these to those in which there is a well-defined central space, enclosed in a fibrous capsule, and lined with a delicate secreting membrane. The development of the various parts is carried further and further, until they differ from each other widely in appearance; but the degree of relationship between them is as near as ever it was; and they are as much connected together, and as closely bound up with each other, as they were before the change. The difference is only one of degree, not one of kind. They become varied in outward appearance and physical properties, because of the different services they have to perform; but they never lose their mutual sympathy or con-

nection. It is impossible for one part of a joint to be injured, or to suffer in any way, without influencing the rest. Joints are not built up, like machinery, of different and separate parts, any one of which can be injured and replaced without interfering with the others; they are living organs, which cannot be healthy if the smallest part fails in its duty.

The Bones.—In the limbs and the more movable joints the modifications are especially great. First, the bones, which are the chief supporting structures, become more highly specialized. Instead of retaining the same uniform character the ends are altered in one direction, the middle in another. The shaft becomes hollowed out and assumes a cylindrical form, the shape well known to mechanicians as the one best calculated to withstand vertical pressure and lateral strain with the minimum expenditure of material. Here and there the compact walls are strengthened by outlying ridges, so that the cross section in some is almost prismatic. The ends, on the other hand, become wide and expanded, to increase the extent of surface that enters into the formation of the joint; often they are still further enlarged by processes jutting out to afford greater strength and security for the ligaments that hold them together, and more advantageous leverage for the muscles that move them. At the same time the internal structure loses its uniform arrangement. Where the range of movement is limited and equal in all directions, the interlacing network of bony spicules, of which the sponge-like interior is formed, shows no well-defined differences either in density or arrangement. The outer layer is merely a little more compact and smooth on the surface than the rest. In the more highly developed joints, no matter in what direction the bones are sawn, the dense tissue that forms the outer layer, and the open-work interlacing bars inside, are always so arranged in arches and curves as to diffuse as far as possible over the whole the pressure that falls on any one spot, and to secure the greatest amount of strength and elasticity with the least weight and the smallest expenditure of material.

Then the surfaces in contact with the opposite bone become varied in direction and outline in order to correspond to the movements. The more active and vigorous these are, the more changed and uneven they become. In the simplest joint they are flat, and face each other directly, only allowing a

certain amount of gliding between them. In others—the shoulder and hip, for example—the extremity of one bone is hollowed out into a cup into which the other fits, more or less accurately, according to the degree of support required. In the lower limb, where the need of this is much greater than in the upper, the rounded extremity of the bone forms more than half a sphere, and is so tightly embraced by the sides of the cup, that, even when everything that holds the bones together has been divided, it requires very considerable strength to pull the two apart. In the shoulder, on the other hand, the cavity is shallow, the head of the bone large in comparison, and the range of movement increased thereby at the expense of the security. In a third class, the ends are so modified with regard to each other, that movement can only take place in one plane as on a hinge. In the elbow, for example, the bone is rounded from before backwards, and fits into a corresponding depression on the other, rotating in it on an axis that runs from side to side. In the ankle there are stout projecting processes, one on either side, so that movement is strictly limited to one direction, and lateral bending is impossible.

When more complicated movements are required, the modifications become greater still. In one instance a ligamentous ring attached at one side is thrown round the neck of a bone, so that it can turn securely in it on its own axis. In another, discs of fibro-cartilage are interposed between the bony surfaces to deepen the sockets and lessen the impact of shocks; or, as in the case of the wrist and foot, a number of small bones are so adjusted to each other that the pressure falling on any one of them is diffused and distributed over all the rest.

The Fibrous Tissue.—These changes are not confined to the bones; in the more movable joints the ligaments become modified quite as much. As already mentioned, in the simplest the fibrous tissue that joins the bones together passes directly from the surface of one to a corresponding point on the other. Where the range of motion is a little more extensive, the part round the circumference becomes more fibrous, the interior softer and more cellular. In those which admit a wide extent of movement the change is carried further still. The soft central space becomes a well-defined cavity; and the fibrous tissue round forms a firm ligamentous capsule, enclosing it, and tying the two bones together.

The Capsule.—Simultaneously with this the point to which the capsule is attached undergoes an alteration. Freedom of movement is easily gained by increasing the length of the fibres; but at the same time stability and security are lost, unless, as in the case of the shoulder, the surrounding muscles replace the ligaments in checking and controlling the action. Accordingly, in all cases in which the range of movement exceeds a very small angle, the fibres no longer pass from surface to surface, or even from margin to margin, but are shifted further back on to the sides of the bones, so that the ends of these are enclosed by the capsule and lie inside the joint. By this arrangement one bone is enabled to glide on the other when any stress falls on it, and freedom of movement is gained without the sacrifice of strength. There are few joints in the body admitting of much angular movement in which one joint does not glide to some extent on the other.

The Ligaments.—The strength of the fibrous capsule becomes modified at the same time. Where the amount of movement is but little, and is equal in all directions, there is a uniform and even layer, extending all round the joint from one bone to the other. When the structure of the bones allows bending in one plane only, as in true hinge-joints, the side portions springing from the ends of the axis of motion are more highly developed than the rest. Each is attached to a point on the more fixed bone, and radiates from this in a fan-like way on to the other, so that the two are firmly braced together in all positions of the limb. At the back and front it is thin and loose, merely serving to protect the cavity of the joint. By steps such as this the capsule of a joint gradually becomes split up into four divisions, which appear to be so isolated and distinct from each other that they are often called anterior, posterior, and lateral ligaments. They are not, however, separate structures in any sense of the term. They are only subordinate parts of the same that have become differentiated from each other by the difference in the character of the work they are called on to perform.

In a ball and socket joint, which, so far as this is concerned, may be regarded as a kind of universal hinge, the capsule is modified in the same manner. In the hip, where unyielding support in front is required, that part is so strong that, even in dislocation, it very rarely gives way; behind, where there

is but little strain, it is comparatively thin and weak. In the shoulder, everything else is subordinated to accurate and rapid action in all directions. The capsule consequently is, with the exception of one part, so loose and long that it only becomes tense when the angle of movement is extreme; the muscles here take the place of the ligaments almost entirely, and not only execute but also control and restrain the movements of the arm with a precision that would be impossible if it were dependent on passive and unyielding fibrous tissue.

The Synovial Membrane.—The cavity of a joint always contains a certain amount of an exceedingly viscid fluid, known as synovia. The quantity is very variable even in the same joint, but in general there is merely sufficient to moisten the surfaces that are in contact with each other, so as to avoid friction as far as possible. It is secreted by a delicate structure known as the synovial membrane. This lines the interior of the fibrous capsule, and is prolonged into all the outlying pouches in connection with it, but does not extend, at least in the adult, over the layer of cartilage that covers the ends of the bones. Before birth an exceedingly delicate film of cells, without any fibres, may be found in this situation; but they are soon worn off, and do not reappear. Where this membrane is folded on itself, as, for example, at the attachment of the capsule to the bone, it is often thrown into folds, which, under some circumstances, are capable of assuming a very considerable size. The inner surface is smooth and polished; the other is continuous with the fibrous tissue of the ligaments, where they serve to enclose the joint; but between them, and in the intervals found here and there extending under muscles, it possesses a delicate wall of its own, formed of connective tissue, and connected to the structures round by a few loose and scattered fibres.

This synovial membrane is in general regarded as a separate and distinct structure, found in those joints only in which there is considerable freedom of movement. In others, it is stated that an imperfect cavity is sometimes developed, but that it is never lined by a true synovial sac. This view is incorrect; neither the method of development nor the changes that take place in disease lend it any support. In reality, the synovial membrane is nothing more than the lining of the cavity, which is developed as the amount of movement in-

creases; and under similar conditions, structures indistinguishable from synovial sacs may be developed in any part of the body.

In the centre of a joint the cells which fill up the space between the bones break down, become liquid, and dissolve away; round the circumference they persist. The outermost, as already mentioned, are converted into fibrous tissues, and form the ligaments, or the capsule, as the case may be; the inner ones, those that immediately line the cavity, form the synovial membrane. The cartilage on the ends of the bones is not covered with it, or it is at most covered with a single layer of cells, because of the relation it bears to the cavity, and because there is no fibrous tissue developed on its surface. In the intervals between the ligaments, where there is nothing to protect the cavity of the joint, it is a little stronger than elsewhere, and may be called a membrane; but it is not an isolated or distinct structure here any more than it is elsewhere. It is continuous on either side with the neighboring ligaments; where it comes into contact with the cartilage it shades off into it, so that it is impossible to say where one commences and the other ends; and its outer surface is part of the loose and delicate connective tissue that fills in all the irregularities round joints, extends under the muscles and tendons, and forms a layer under the skin.

Mutual Sympathy of all the Parts.—Joints are commonly regarded as composed of many different structures, all of them separate and distinct from each other, with different and independent functions. There are ligaments to hold the bones together; a synovial membrane to render the movements smooth; cartilages over the ends of the bones to lessen the impact of any shock; and round them, filling up all the interspaces, a quantity of loose and delicate connective tissue, containing the blood-vessels and nerves which supply the joint.

This view may serve for the purposes of ordinary descriptive anatomy; but it gives an altogether wrong impression of the nature of the injury sustained when a joint is sprained, and of the causes of the complications and after-troubles that follow with such frequency. The bones that form a joint, no matter how many there may be, or how great may be the varieties of their shape, are surrounded and held together by connective tissue, which is structurally continuous with them. It bridges

over the interval between them, fills up all the interstices left by the muscles and tendons, and forms an investment for these and every other structure near. One part, where there is much tension, becomes dense and unyielding, so that it is known as ligament; in another the cells undergo a process of liquefaction, and a cavity is formed; the limiting wall of this is differentiated into a synovial sac, and a membrane more or less distinct is developed from it. The different structures lose all external resemblance to each other. What they do not lose is their relationship from their common descent. Throughout the whole of life the closest sympathy persists between them, so that it is impossible for any one of them to suffer by itself. It follows as a natural consequence from this that sprains can never be the simple things they are usually considered, or be confined to the mere stretching or tearing of an isolated ligament. The immediate effect of an accident may fall upon the ligaments, or it may not; it can never be limited to them. The capsule of the joint is opened up, the cartilages bruised, the muscles torn, the tendon sheaths strained, the interior filled with blood, and so much more extravasated into the tissues round that the strain may extend the whole way up a limb, and may not disappear for six weeks. Very often, in spite of the popular belief, the ligaments are the part that suffer least: they certainly never suffer alone.

Even if by any chance they were the only structures hurt at the moment, it is impossible for the other tissues to remain unaffected during the changes attendant on their repair. A wheel or a band in a piece of machinery may be damaged and restored without interfering with the other parts. When a ligament is hurt a certain amount of blood escapes into the synovial sac and the spaces round; all the vessels dilate; the synovial folds become swollen; the joint is tender to the touch; the temperature of the part is raised; its movements are interfered with; even the external shape of the limb is altered. Nothing escapes; every structure round participates more or less.

The same is true of the later troubles that so frequently impair the freedom of movement in joints long after they have been sprained. The stiffness, for example, that is often laid to the credit of a contracted tendon, or shortened band, is never due to this alone; nor is the sense of insecurity dependent en-

tirely, or even to any extent, on the weakness of an injured ligament. It is only by taking a wider and more comprehensive view of the structure of joints, and by regarding them as organs of the body, wonderful in their complexity, that a true conception can be obtained of the nature of the damage they suffer in sprains, and of the method in which they should be treated, so as to avoid, as far as may be, the occurrence of permanent injury.

CHAPTER II.

CAUSE AND PREVENTION OF SPRAINS.

WITHOUT going so far as to say that sprained joints can be entirely prevented, there is no doubt that it is possible to avoid and guard against them to a very considerable degree. In some people they are particularly common; and so they are at certain times, and under certain conditions. Others escape in a manner that seems almost marvellous, and possess the power of using their joints in a fashion that would be impossible in the majority.

The Condition of the Muscles.—This depends mainly on the condition of the muscular system. The strength and security of the articulations are assured in proportion to the perfection of its development. Sprains never occur unless the muscles are either weakened and tired out by prolonged exertion, or are caught unawares by some sudden slip, before they can recover themselves. Astley Cooper said of dislocations that it was only possible for them to take place when the muscles were unprepared for resistance; otherwise the greatest force would hardly produce the effect. Without saying so much of sprains, there can be no question that such accidents rarely happen unless the muscles that safeguard the joints are taken by surprise. Ordinarily speaking, they are the result of a sudden twist, so rapid that recovery cannot take place in time, and naturally this is most likely to happen to those who have never accustomed their muscles to much exertion, or who, from fatigue, have lost that instinctive vigilance and power of recovery essential to the safety of a joint.

This, among others, is one reason why sprains, especially of the knee and ankle, are so common among women, and those men who, in their youth, were distinguished for athletic feats. In the former, the muscles are insufficiently exercised, so that they never attain the vigilance and instantaneous power of response necessary to prevent the consequences of a

careless step; in the latter, with advancing years and altered modes of life, the muscles fall out of training, without its being perceived, or perhaps sometimes without its being acknowledged. Then some unusual effort, especially a prolonged one, that in days gone by would have been accomplished easily, proves too much for their endurance under the altered conditions, and something gives way. Unhappily, when this has taken place once, the joint often remains, as it were, a weakened spot, and there is always the possibility of the same thing happening again and again, with greater ease each time.

The muscles are really part of the joint as much as the bones or the synovial membrane. It may be more convenient to describe them separately, but the function of a joint is movement, and in considering the way in which sprains interfere with this, the muscles that execute and direct it are as much concerned as the ligaments, which have only the passive duty of checking it when it is excessive. This is true of all joints, but especially of those in which the freedom of movement is greatest, and which on that account are the most exposed to strains and injuries of like character. As Morris has pointed out, the strength of any single joint, and its power of resisting injury, are inversely proportioned to its freedom of mobility.

In the more fixed joints, where there is only an indistinctly marked cavity in the centre of the fibro-cartilage, the muscles are short and broad, with much inelastic fibrous tissue in their composition, and often are so arranged with cross-running and interlacing fibres that while one bone is moving on the other it is held even more firmly in contact with it than when it is at rest. Where, on the other hand, the range of movement is extensive, the security of the joint is often dependent entirely on the muscles. In the shoulder, for example, there is a fibrous capsule surrounding the ends of the bones, and forming the apparent bond of union between them. But it is so loose, and has so little influence in controlling movements, that if the muscles are paralyzed the arm drops down for upwards of an inch. Here in particular, owing to the need of accuracy and delicacy, combined with strength and rapidity, the function of controlling the movements of the joint is assigned almost entirely to those structures which originate them. The muscles take the place of ligaments.

When this occurs their shape and arrangement are modified. They become divided, roughly speaking, into two sets. Some are short and broad, and immediately surround the joint. These maintain the proper degree of pressure between the bones, and keep the action smooth. Others are much longer, and are attached to distant points by means of rounded tendons, which lie in grooves lined by a delicate sheath. On these depend the vigor and rapidity of the movements. They differ greatly in size and direction, but the connection that exists between them and the joint is no less intimate; the same nerve supplies them both. They are really but different parts of the same mechanism, so closely united together by the bond of common descent, and so associated with each other by the identical nature of the nerve supply, that it is not possible for one of them to be injured and the rest escape.

The same is true of the skin that covers them in and protects them. This, too, is supplied by the same nerve, and when the joint or the muscles is injured cannot help being affected at the same time. Illustrations of this are of common occurrence as the result of sprains. It has often been remarked that after prolonged and severe exertion the skin over the insertion of the muscles, and in certain spots over joints, becomes exquisitely tender from its sympathy with the parts beneath. It does not arise from any irritation or inflammation of the skin itself, for nothing has happened to affect it in any way. Yet the slightest touch gives rise to the feeling of actual pain. Firm pressure, on the other hand, relieves it, not, as is often said, because it is hysterical and imaginary, but because of the numbing effect of compression on the superficial cutaneous nerves. Plainly the skin, which is an exceedingly sensitive structure, is suffering in sympathy with the overworked organs it is intended to protect.

The Muscles as Ligaments.—The muscles, therefore, must be considered in a twofold relation to the joints. On the one hand they are the sole agents for executing movements; on the other, under all ordinary circumstances, they take the place usually assigned to ligaments, and act as the main safeguard. So long as the action is confined within moderate limits the ligaments are entirely unconcerned; they are merely passive bands of inelastic fibrous tissue, so loose as to have no restraining power until a certain angle is reached. Then they

suddenly become tight, and bring the movement to an abrupt conclusion. The muscles, on the other hand, are always tense, no matter what may be the position of the limb. No movement, not even the bending of a finger, is so simple that it can be carried out by the action of a single set; the opposing ones must always act with them, so that the movement may be even and steady, not disorderly at its commencement, or brought to a sudden standstill at its close. The firmness and security of the joints—except such as the knee—in all their positions are entirely due to the continuous steady contraction of opposing groups of muscles. They are the agents which prevent movement being carried too far, so that under ordinary conditions strains do not fall on rigid and inelastic ligaments. When from fatigue or carelessness this does happen, the ligament may be strong enough to resist, but more often—especially in the joints with free movement—it stretches or tears, and a sprain of greater or less severity is the result.

Under these conditions the muscles sometimes suffer, while the ligaments escape. The injury may be immediate, or not show itself until some time has elapsed They may be torn or bruised by the violence with which the bones are wrenched apart; or what is, perhaps, more common, hurt themselves by the sudden and almost involuntary attempt at recovery when a slip is threatened. If they escape at the moment they may suffer even more seriously at a later period from wasting, rigidity, or degeneration, so that in severe cases they become converted into dense unyielding bands. This, perhaps, is not a common occurrence when recovery is rapid, though it is by no means unknown; when it is delayed, they rarely fail to show that they have undergone some kind of change, and that they are not so perfect as they were before.

The Effects of Muscular Development.—Besides, however, acting as a safeguard and protection against accidents of this nature, the muscular system is of great importance in another way. The degree of perfection to which joints attain—and naturally they differ immensely in this respect in different individuals—is dependent entirely on the extent to which the muscular system is developed.

Where the muscles are poor and feeble the joints are poor and feeble too, and are easily sprained. The ends of the bones, instead of being angular, with sharply-cut and well-defined

edges, are smooth and rounded. The articular surfaces are faintly marked, so that they can glide on each other in irregular and unusual directions; the capsule is loose and yielding, and the ligaments, without the assistance of the muscles, are unable to withstand the least strain, or even to maintain the normal relation of the two bones. The action of the joint is uncertain and often painful, and the loss of power is proportionate. In case of any extra work the bony surfaces glide irregularly on each other, and move beyond their ordinary limit. The more often this takes place the more easy it is for it to happen again. Each time it is always carried a little farther than it was before, until at length, some day, one bony prominence is caught behind another over which it has slipped, or a tendon or disc of cartilage escapes from its bed, and the joint is locked. Pain and swelling rapidly follow. The patient may be able to restore things to their natural position at the first, but more often some assistance is required. The serious thing is that when this occurs, as it is wont to do more and more often, the joint never has time to recover its natural condition, and is left permanently damaged.

The principle that the more a part is used, within, of course, rational limits, the more perfect it becomes, has long been recognized in the case of bones. The skeleton of the male is very different from that of the female; the work is harder, and the bones become stronger. In the one they are solid, heavy, and exceedingly irregular, from the development of muscular ridges; in the other they are lighter altogether, and much more smooth and even. So with animals that have long been kept in confinement, the bones, contrasted with those of wild ones of the same species, scarcely admit of comparison, the difference is so great. It is the same with the muscles. As Humphry has pointed out, there is a difference almost of kind between the slender, compact frame and wiry, active muscular system of the thoroughbred, and the coarser, heavier, and more clumsy tissues of the cart-horse.

What is true of the shafts and muscular eminences of bones is equally true of their articular ends, and of the rough surfaces to which ligaments are attached. Joints are well formed and secure from injury, so far as shape can make them, in proportion to the amount of their use and the perfection of the muscular system.

Chronic Sprains.—Such a condition as the one I have described above may be almost called a state of chronic sprain. So long as it is slight it does not attract much attention. There are complaints of loss of power, and of twisting or giving way, but, as a rule, the deformity is not conspicuous, and especially as it is most common in children, it is put down to what is called growing pain, a name which has probably done as much harm as any other by the way in which it makes light of what often is the commencement of a serious disease. When it is more severe, or when during some unaccustomed effort the limb fails completely, the joint is generally said to be out. The pain is very severe; swelling soon makes its appearance, owing partly to the unnatural position of the bones, partly to the effusion round; and, owing to the insecurity of the joint, the loss of power is so great that the patient often believes himself paralyzed. It is serious, not on account of the tearing of the capsule or the injury to the parts around, but because the cause is such a persistent one, because the condition of things which has given rise to it is one that requires a long and systematic course of treatment before it can be rectified.

One of the earliest and most characteristic examples I have seen was in a young girl who was brought to me complaining of partial paralysis of the right arm, attended at times with attacks of severe pain. She was a tall, overgrown girl fourteen years of age, employed as a nursemaid, having to carry about a heavy child, and owing to this condition of her arm, which had been coming on gradually for the last three or four months, had lost her situation. She was not aware of having sustained any single severe injury to her shoulder; but stated, of her own accord, that long before it reached its present state it was continually giving way, or, as she expressed it, coming out of joint. On comparing the two sides together, it was evident that the muscles round the shoulder joint on the affected side were smaller than those on the other, though the difference was not equally marked in all. The movements were limited to a great extent by the pain they occasioned, and the general muscular strength was decidedly below normal. The cause was apparent at once; there was a large amount of thickening over the point of the shoulder round the joint, that is to say, between the collar-bone and the shoulder-blade; and

the bones were so loosely connected together that the end of one could easily be made to slip backward and forward over the end of the other. When the shoulder-blade was held in position by firm pressure from behind, the movements of the arm could be executed nearly as well as those of the opposite limb, and with nearly as much vigor, while the wasting diminished so much that evidently it was in the main apparent only. As soon as the pressure was taken off, the bone at once underwent considerable rotation, the upper border being so much displaced that a deep hollow made its appearance behind the collar-bone, which slid in such a direction that the two completely lost their normal relation to each other.

The fact that the wasting almost disappeared, and that the movements could be executed with ease as soon as the shoulder-blade was fixed, quite negatived the idea of paralysis. The slight amount of real wasting, affecting only a few of the muscles, could easily be accounted for by the inflammation of and round the joint; wasting much more extensive than this sometimes under these circumstances comes on within a week. There was no history of any accident sufficiently severe to suggest the idea of a dislocation with rupture of the ligaments; the onset of the mischief had been quite slow and gradual, though every now and then the pain—which had, as usual, been called growing pain—and the inconvenience had suddenly become worse. For the same reason it could hardly be termed a partial dislocation; the capsule was not torn, and the whole thing had come on slowly and imperceptibly, so that the patient could assign no date at all for its first commencement. The characteristic features were the weak muscular development, the imperfection in the shape of the articular ends, and the loose yielding condition of the ligaments. So long as no extra strain fell on the joint, the muscles, weak and feeble as they were, were sufficient to maintain the surfaces in contact; a little extra work, slowly and gradually in this case, tiring out the muscles, allowed the strain to fall on the ligaments, until, as ligaments always will when subjected to long-continued tension, they gradually stretched more and more, and became so loose that the end of one bone could slip backward and forward and ride over that of the other.

A similar case, differing, however, in the joint affected, that between the collar-bone and the breast-bone, and in the fact

that it was distinctly made worse by one rather severe strain, came under my notice almost the same day. The patient, who was also a girl, aged about 18 years, had suddenly felt a severe pain in this joint two days before as she was trying to lift a heavy weight, and, of course, had been told the joint "was out." At the first glance this did not seem unlikely, for the inner extremity of the collar-bone was much too prominent; but there was very little swelling or tenderness, and no bruising whatever. On further inquiry, too, it was elicited from the patient that for some months past the arm had felt very weak and unsteady in its movements. Examination of the opposite joint showed that it was nearly in the same condition, and, in fact, the bones on both sides were so loose that they could be pushed almost as far backward and forward as they could upward. Clearly, the ligaments were unusually lax, and two days before, when an unaccustomed strain fell on the right joint, it gave way, causing so much pain and inconvenience that the patient was compelled to seek advice.

These two cases are, perhaps, somewhat exaggerated examples, because in both the already loose condition of the ligaments had been intensified by severe strains; the same state, however, exists independently of these, and no joint in the body is exempt. The shoulder, as might be imagined from the description already given, is peculiarly prone to suffer. If the joint is poorly developed, or the muscles on which it depends for its security are lax and feeble, it can readily be made to assume abnormal positions. Sometimes this occurs with any movement, more often only with certain definite actions; in one case, a girl of 16, whom I watched for a long time, whenever in dressing of a morning she placed her hand on the back of her head in trying to arrange her hair, the upper end of the humerus slipped over the edge of its socket, and was caught there. At length she learned by a clever twisting action to bring it into its place again, and even gradually to avoid displacing it altogether.

In the elbow joint, from the shape of the bones, this accident can scarcely happen; but the same condition of things occurs. Examples may often be met with in which the forearm can, without any violence or pain, be bent back to an abnormal extent on the arm; the ligaments in front are so loose that they do not check the movement sufficiently, and the

bones so feebly developed that their projecting extremities do not come into contact with each other until the normal range is greatly exceeded.

In the case of the lower jaw it has long been known. Hamilton described it as occurring in his own person, and, naturally, with the greatest possible accuracy. He has noticed, also, the curious circumstance that this displacement, when it does occur, is much more common in the morning than at any other time of day. Particularly at breakfast the lower jaw, owing to the looseness of the ligaments that should restrict its action, is apt to become locked when the mouth is opened at all widely, and some manipulation is required to bring it back again.

Whether the same thing can occur in connection with the hip is, I should think, very doubtful. I have seen one patient who could at will dislocate her thigh-bone by a peculiar twisting of the limb; but in the absence of any history that could be relied on, and as her other joints gave no sign, which they almost certainly would have done in such an extreme case, I should imagine that probably this condition had existed from birth, by virtue of some congenital defect. In the knee minor degrees of it are quite common, not only allowing abnormal movements of the leg upon the thigh, but also giving too wide a range of action to the semi-lunar cartilages in the interior of the joint, whereby, perhaps, at length is brought about the beginning of a most serious affection known as internal derangement.

It is singular that this condition of the joints, which is very common in slighter degrees, and very striking in the exaggerated form I have described above, should have attracted so little attention. Sir Astley Cooper has described it in the case of one joint. Hamilton mentions it from his own personal experience in another. Malgaigne gives a vague account of something similar, but although he regards it, quite correctly, as the consequence of debility, and often determined to one particular joint by a local trouble, such as a sprain, he does not appear to recognize it as a general condition, affecting many joints at one and the same time; and he fails altogether to separate it from cases in which the capsule or ligament have been weakened, or stretched by inflammation, or by the passive accumulation of fluid in their interior. It is even more

strange that he fails to appreciate the fact that the ligaments, though undoubtedly concerned in the production of this condition, are in reality only passive agents, and not in any way the immediate cause. He states that it is due to an essential relaxation of the ligaments, though he fails to describe what this may be. In reality it is the muscular system that is at fault; for on this more than anything else depends the perfection of the joints, and the strength and power of resistance of the ligaments.

The secret of it all is to be found in the feebleness of the muscular system. In the first place the joints are weak, and the ligaments loose, because they have not been properly exercised. Then the muscles are not equal to any amount of work. When a little extra labor falls on them (and very little is needed in cases such as these) they soon become fatigued; the joints lose their support, and either the already feeble ligaments yield slowly and steadily, with a very considerable amount of pain, as ligaments always will yield when exposed to any severe strain; or else, owing to some sudden slip, the weight of the body falls on them before the muscles can save them, and some permanent injury is the result. It cannot be too clearly laid down that not only do the joints depend for their perfection on the degree of development of the muscles, but that, at any moment, the contraction of the muscles round a joint is as essential to its security as the ligaments, perhaps more so. If they yield, the ligaments will never hold for long.

Effects of Age on Joints.—One other feature in the construction of joints cannot be passed over in silence, as it helps to explain why sprains in some people are so liable to be followed by complications from which others are quite exempt. The joints are not alike at any two periods of life. It is acknowledged that they do not attain their highest stage of perfection until adult years are reached, but even after this their most important features undergo continual modifications. In infancy, adult life, and old age there are vast degrees of difference in their structure, due partly to the way in which they have been used, partly to the natural changes that take place in them as age advances, and partly to disease.

Leaving aside for the present this last consideration, the differences that exist between the joints at various periods of life are most striking. In the infant the surfaces and edges

of the cartilages are rounded and smooth, closely fitting together at the centre so as to leave between them merely a cleft, which widens a little, but very little, at the margin. The shape of the joint cavity is well defined, regular, and even. There are no outlying pouches or projecting fringes; everything is as simple as it can be. The fibrous capsule round presents the same features. It is, it is true, a little stronger in one part than it is in another, but there are no great accessory bands of dense unyielding ligament. All is soft and delicate in structure, shading off imperceptibly into the surrounding connective tissue, and what is, perhaps, the most important feature of all, exceedingly richly supplied with blood-vessels. In the adult these are confined almost entirely to two circles which surround the ends of the bones, where the capsule is attached, and send loops into the folds and fringes which abound there. In the child, and still more in the infant, not only are they larger and more numerous in proportion to the size of the parts, but they extend over the whole circumference, and are not limited to any single region. In consequence of this, when inflammation arises, no matter what may be the cause, its course is much more rapid, and the exudation of lymph infinitely more profuse. In children sprains are attended by an altogether disproportionate amount of swelling, and probably many of the complications that occur in them are due, not so much to inherited tendency as to the extraordinary richness of the blood supply, and the rapid and tumultuous character of the tissue changes that take place under such conditions.

All through life, not merely in youth, but even in old age, this undergoes continual change. The difference is not only one of size, but of structure, arrangement, and relation. The cartilage is replaced by bone, with the exception, as already mentioned, of the layer that directly lines the cavity. The edges become sharp and well defined, and the surfaces are no longer moulded accurately to each other. The capsule increases in strength and thickness. Where the strain is great the delicate connective tissue becomes dense and unyielding ligament; in other places it forms a close and even membrane round the central space. But these alterations, great as they are, are slight when compared with those of the synovial cavity and its delicate lining. This not only increases in size in

proportion to the growth of the joint, but becomes greatly changed in shape. Pouches are thrown out round the bony projections and into the weaker parts of the capsule until in outline it bears scarcely any resemblance to what it was at birth. Accessory spaces, known as bursæ, are developed wherever there is friction, under tendons, for example, or between bones and muscles. These differ in each individual both as regards shape and position. As age advances they become larger and larger, until at length they encroach to such an extent on the lining membrane of the joint cavity that the intervening partition gives way, and a communication between them is established by an opening which grows wider and wider each year.

While this is going on the surface of the lining membrane does not lag behind. It does not remain smooth and regular, merely folded on itself where it is reflected on the bones. Projections grow into the cavity from all sides. Some spring up from the spot where the capsule is attached to the bones, so that these are surrounded by a ring of fringing growths. Others project inward from the ridges and inequalities of the surface or the margins of the openings already mentioned. Some are short and smooth, others long and branched. In some the end expands into a rounded body containing cartilage corpuscles, while the neck grows thinner and thinner until it gives way and allows it to drop off. Many of them contain loops of vessels, especially when they grow from the region of the vascular circles; other are merely masses of fibrous tissue. There may be only a few scattered about, or the whole interior, especially if examined under water, may be covered with a dense shaggy coating under which it is no longer possible to recognize the polished regular surface met with in youth and childhood.

It is often difficult to tell how far these changes are the result of age, or to what extent they are the direct consequences of disease; the two so often go together hand in hand. The effect is that in no two persons are the joints ever alike; and the older they become, the more work and the harder the work they are called upon to do, the greater the changes and the wider the difference, until at length it is scarcely possible to find a resemblance except in the broad general features of construction.

CHAPTER III.

DIAGNOSIS.

It is not often that there is much difficulty in the diagnosis of a sprain, particularly if the joint is a superficial one, like the ankle or the knee. The nature of the accident, the sudden onset and peculiar character of the pain, the rapid swelling of the part, and the helplessness of the limb, are in general quite sufficient to convince the patient of the misfortune that has befallen him. But as, short of actual dislocation, nearly every kind of injury that can involve either a joint or the tissues in its immediate neighborhood, is called a sprain, this is scarcely sufficiently definite. In no other kind of accident do precision and exactness of diagnosis repay more thoroughly the pain and trouble of careful examination; nowhere is it more essential to form a definite conclusion as early as possible, not only of the kind of hurt sustained, but of its extent and degree. Even then it often happens that constitutional peculiarities, or other agencies less easily controlled, assert their influence, and seriously complicate the progress of the case.

Dislocations, fractures in the neighborhood of joints, and, in the case of children, separation of one of the growing ends of the bones, present the greatest amount of difficulty. In connection with this, there are one or two points which it is advisable to bear in mind. In the first place, in many joints, and particularly in those in which, like the elbow, complicated accidents are of common occurrence, an enormous amount of swelling sets in with such rapidity that all the prominences by which the relative position of the bones is ascertained are buried and lost in a very short time. Consequently, if the diagnosis is not made at once, immediately after the accident, it is necessary either to put the patient under an anæsthetic or to wait without a definite opinion for days, perhaps even for weeks, until the swelling subsides. The importance of this is so great that, especially at the present day, there ought to

be no hesitation about the administration of an anæsthetic. In the case of children, it is often impossible to form an opinion without; and even when it is, the risk is so exceedingly slight, the relief from pain so great, and the advantages of being able to examine the joint thoroughly without any muscular rigidity, and to apply the first dressings quietly and systematically, so immense, that they ought to be made use of where there is the least occasion. Nothing is more common than to meet with cases in which, from neglect of this precaution, because the first examination could not be thorough, joints have remained stiff or imperfect in their action throughout the greater part of life.

Further, if there is the slightest question as to the nature of the injury, whether it is a fracture involving a joint, or a sprain, the patient must always be given the benefit of the doubt, and the injury treated as if it were the more serious of the two, with this precaution, that passive motion must be resorted to, and the joint thoroughly worked at a much earlier period than it would be in the case of a simple uncomplicated fracture. It is probable that sprains of the ankle are very frequently confused with fractures of the small bone of the leg, and even with Pott's fracture without displacement of the parts; but as the immediate method of treatment adopted in these instances need not differ materially, no ill result follows, provided passive motion is adopted in time. Stiff joints, whether they are the result of fractures or of sprains, result most often from retaining the part immovable in a fixed apparatus for weeks together.

There is one further caution which it is necessary to observe, one that was originally suggested by Nélaton. It sometimes happens that, even when only a single joint is complained of, one or more of the others in the same limb has sustained some hurt, though of less severity. Consequently it is as well, when examining a sprained limb, always to commence by investigating the movements of the joints which the patient declares not to have been hurt; otherwise they may easily be overlooked, and some time later an aggravating degree of stiffness found that might easily have been avoided by the exercise of a little precaution. There is this further advantage, though it may not be worth much, that the patient, when the joint that really has been injured is taken in hand, knows

what is going to be done, and is less apprehensive of any rough movement.

The same thing may happen when one of the bones is broken; a sprain and a fracture may occur in the same limb from the same accident, and owing to the great amount of attention paid to the one, the other may be altogether overlooked. Dr. Bennett, of Dublin, narrates the case of a man who slipped as he was carrying a heavy sack down a sloping plank. His foot was suddenly checked in its slide by some irregularity, and he fell, conscious at the time that something had given way in his leg. Admitted into hospital, as he was unable to bear any weight on his limb, he presented the ordinary features of sprained ankle, without any sign of fracture. The case was treated as a severe sprain, and attracted but little attention for some days, until it was noticed that there were some signs of bruising on the upper part of the leg. On examination, the localized pain, and the crepitus characteristic of fracture, left no room for doubt as to the diagnosis. In addition to his sprain, the small bone of the leg had given way a long distance from the ankle, though he was certain he had not struck it in his fall. The amount of displacement of the broken ends was very slight; the line of fracture was oblique; and there is no doubt it might easily have been passed over altogether. Probably, as Dr. Bennett suggests, accidents of this kind are much more common than is usually supposed.

Swelling.—Much of the difficulty of diagnosis arises from the variety of the symptoms presented by sprains; they are scarcely alike in any two cases. In hinge joints, for example, the mischief falls on the ligaments which oppose a twisting force; in a ball and socket arrangement, the muscles, as a rule, are the greatest sufferers. Sometimes, especially when it is due to hæmorrhage, the swelling makes its appearance at once, and accurately reproduces the shape of the synovial sac. At others the bursæ or the tendon sheaths in the neighborhood are distended, so that this is quite concealed, or there are extensive extravasations into the loose cellular spaces underneath the skin and between the muscles. Or, again, the swelling may commence slowly and gradually, twelve, or even twenty-four hours after the injury, and be smooth and uniform in outline from the very first, owing to the effusion into the soft tissue round as well as into the joint itself.

Very often it is most distinct over the course of the muscles and tendons. The skin, for example, on the outer side of the forearm is raised and puffy over the insertion of the pronator radii teres, or there is a long, low, rounded swelling on the back of the wrist, running obliquely across the joint over the course of the extensor muscles of the thumb. It is quite soft—so soft, indeed, that it can often be appreciated better by the eye than by the finger—never very great, because there is no cavity of any size in which fluid can collect, but exceedingly tender when touched.

Sometimes, instead of the bony prominences being partly buried by the collection of lymph round and between them, the reverse of this is the case. They are increased in size, and stand out under the skin in such a way that there may be some apparent ground for the common conclusion that the joint is out. In the wrist and hand this is a very frequent mistake, and it really is difficult sometimes, when one of these points is projecting beneath the skin, to prove that the bone has not slipped out of its place and been dislocated.

The styloid process of the ulna on the inner side of the wrist is a favorite spot for this. It is often unduly prominent after an attack of gout or rheumatism, and, even when it is certain there has been no injury, it is frequently described as being out. So with the base of the metacarpal bone of the middle finger, which, when the wrist is strongly bent, raises up the skin on the back joint. This often forms a projection, especially in gouty people, varying in size from time to time, and occasionally appears quite suddenly after even slight exertion. Probably it is due to a strain of the tendon attached to this point, and to the amount of effusion thrown out round the bone, but it is nearly always asserted that something is out of joint.

Other parts of the body are not so liable to mistakes of this kind, in all probability because they are not exposed to such continual and minute examination. In the knee and elbow, even, considerable differences are not noticed unless they have appeared suddenly. Natural projections may increase in size, fresh ones may form, or what is perhaps more perplexing still, small ganglions may develop in such places as the outer side of the knee joint, just below the level of the knee cap, and at the same time there may be real impairment

of mobility and strength, but unless this happens suddenly, or, what is far more common, is noticed suddenly, little attention is paid to it. When there has been a recent accident the diagnosis is sometimes very difficult, and requires the greatest care.

Staining.—Valuable information may be gained sometimes from the place at which the bruising first shows itself. Blood effused deep down in a limb, as, for example, between the superficial and deep muscles of the calf of the leg, or in the groin, always follows certain well-defined routes, being guided by the anatomical structure and the arrangement of the sheets of fascia. When the limb is bandaged it is often driven great distances by the pressure before it can reach the surface.

Sometimes its distribution is very peculiar. I have seen several instances in which, after a severe injury to the deeper parts of the hand, dark purple crescents caused by blood-staining made their appearance between each of the fingers, just above the web where they divide. Owing to the attachment of the palmar fascia, the coloring matter had soaked through to the skin in a regular and symmetrical pattern.

Pain.—The character of the pain, if the patient can describe it, may be of great help. When the strain falls on the ligaments it is usually said to be sickening, and a patient who has suffered from it once rarely fails to recognize it a second time. It is very sudden, often so severe as to cause the sufferer to faint, and then gradually, if the joint is kept quiet, passes off again, leaving an aching deadness of the limb, but coming back in an aggravated form on the least attempt at movement. This is well marked when a tendon, or one of the internal structures of a joint, slips from its place. So long as the part is kept perfectly still, even if the position is abnormal, the pain is only moderate in severity; it becomes worse and worse as the structure shifts from side to side, until just as it slips back into its bed it is as severe as ever; then it suddenly ceases. The cause at first is the forcible stretching of the ligaments; the later aching seems, in the majority of instances, to be proportionate to, and therefore probably dependent on, the amount of distention of the joint.

Tenderness.—Muscular strains, on the other hand, are distinguished by a peculiar sensitiveness of skin, most marked over the points of attachment to the bones or tendons. These,

as a rule, are the weakest spots, where they give way first. If they are even touched the patient shrinks away with the pain; but curiously enough, very often steady, gentle pressure is well borne. The same thing happens when the muscles are overworked, especially during convalescence. At this time the exertion even of sitting upright is sufficient, because the work, trivial though it is, is too much for the muscles in their weakened state.

When a muscle is torn across, either wholly or partially, as in some cases of lawn-tennis leg, the symptoms are of a totally different character. There is a sudden sharp pain, like that of a blow with a whip or a cricket ball, so that the patient turns round to see who has struck him, before he is aware that anything has given way; and then, as the swelling begins, this is followed by a feeling of stiffness and soreness, severe even when the limb is at rest, but so much worse when an attempt is made to use it, that the patient often can hardly be induced to try.

Dislocation of a muscle is not unlike this. There is the same sudden pain, and the part is held fixed in the position of the moment, no matter how inconvenient it may be. If, for example, one of the muscular slips in the neck is displaced by some irregular movement, the head is kept rigid in the position into which it was twisted. It is not possible for a time to bring it straight again, much less to make it face in the opposite direction; only after the first pain has subsided can it be brought round by slow degrees. Even then, as soon as the attention is withdrawn, it quietly, but surely, moves back so long as the displacement is uncorrected. When the parts are restored there is nothing but a sensation of soreness, with a tender spot or line in the neck corresponding to the particular slip displaced.

These tender spots often afford valuable information. They may persist long after apparent recovery has taken place, and they generally point to something which is not quite restored. In a sprained ankle, for example, if one of the lateral ligaments has given way, or has torn off a scale from the bone to which it is attached, that spot remains tender for weeks after. Sometimes they indicate the presence of adhesions, or of tough contracted parts of the capsule; occasionally they correspond to the situation of synovial fringes, or foreign bodies, or to the

places at which the nerves enter the joint; and in one or two instances I have known them caused by extravasation in the substance of the capsule itself.

Allowance must be made for those that are normally present when a joint is hurt. What they are caused by is not always certain, but as a rule they correspond to places where the capsule is thin and flexible, and not far removed from the surface, so that pressure falls on it directly. However this may be, they are so constant and definite that it is scarcely possible to mistake them. There is one, for example, nearly always present on the inner side of the knee-cap, about the middle of the joint; in the hip it lies behind the projection of the trochanter, and sometimes there is one also on the inner side. In the ankle they are not so marked, but there is very generally one on the front of the joint, rather to the outer side of the middle line. These are present with such regularity that they must almost be called normal. When other more unusual ones are found there is some additional reason to account for them.

Sprains and Dislocations—the Elbow in Children.—Sprains and dislocations are sometimes very confusing, even without taking into consideration the popular view that something is out of joint in every sprain that does not get well at once. One instance in which there is great difficulty in distinguishing them has been mentioned elsewhere, and it would be easy to multiply them. There is, for example, a peculiar injury about the elbow, only met with in children, concerning the nature of which there is still very considerable doubt. It is caused by the way in which they are swung round by the hands, or lifted across a road; and is rarely seen immediately, for though the child cries out with the pain, there is no distinct or objective sign of anything wrong. Then it is noticed that the arm is not used as freely as the other; that the child always cries when it is touched; and that it is held constantly in one position, the elbow slightly bent, and the palm of the hand looking downwards. Now, certainly, in the majority of instances the seat of the mischief is in the elbow joint (J. Hutchinson, Jun., "Annals of Surgery," 1885); and it is highly probable that it is due to one of the bones of the forearm, on which nearly all the weight falls, slipping out from under the ligamentous collar which holds it in its place. But this view

is not by any means universally held; others, describing the same accident, produced in the same way, causing the same symptoms, and, more than all, cured by the same manipulation, have assigned it to a totally different joint, the wrist.

It is even mistaken for fracture sometimes, for a very simple but altogether insufficient reason. If the elbow is held firmly with one hand, while the forearm is made to rotate slowly from side to side, there is a clicking or snapping sensation, perceptible both to the ear and the touch. Then something is felt to slip, and in general free use of the joint returns immediately. But sometimes this is not so easy; reduction does not take place at once; the peculiar sensation continues, and may even become more plain, until it is really difficult to distinguish it from the crepitus of fracture. It is needless to remark that whatever may be the actual nature of the hurt sustained, it can scarcely be this. If the displacement is rectified, and the arm kept quiet for a day or two, recovery is nearly always complete and thorough, which, under such conditions, would, of course be quite impossible.

These cases are of everyday occurrence; though there may be minute points of difference, they resemble each other in all important features; the anatomy of the part is thoroughly well-known; the way in which the mischief is produced can generally be ascertained; and there is nothing mysterious, or even unusual, in the manipulation by which the parts are restored. Yet in spite of all this, not only is the actual nature of the injury doubtful, but even its locality is uncertain. When there is no history to be obtained, or only one that is confusing and misleading, and when the limb is stout and shapeless, or so much swollen that nothing can be definitely felt, the difficulty of forming an exact opinion, of making absolutely certain at once that the joint is not dislocated or the bones broken, may be easily imagined.

The close resemblance that exists between many dislocations and some forms of sprains ceases to be astonishing if it is remembered that, as Vidal de Cassis pointed out, they are really the same thing, only that in the case of the former reduction has taken place spontaneously. In the one the articular ends, which at the moment of the accident are wrenched apart, slip back again into their natural position of their own accord; in the other they slip still further aside.

Sprains and Fractures.—Ordinarily speaking there is not much difficulty in distinguishing sprains from fractures. One may easily be overlooked when both are present at the same time, especially if they occur, as they easily may, at the same spot; but in other cases the signs are usually distinctive. The rough grating sensation when two broken ends rub against each other, the undue mobility, deformity, and pain present in most cases of fracture, are nearly always sufficient, though, as will be described later, some of these signs may be imitated exceedingly well by other conditions. If, however, the bones are so driven into each other by the violence of the accident that there is no undue mobility, especially if in addition the line of fracture runs through that part of the bone which lies immediately inside the capsule of the joint, it is not always easy to make a distinction.

In the case of the hip this is well known, but accidents of a similar description, with or without impaction, are met with sometimes in other joints as well.

Sprain Fractures of the Thumb.—The thumb, for example, is liable to a peculiar form of injury, the real nature of which has only recently been explained. It follows in general a severe strain. The ball of the thumb swells up at once, and all power of bending it into the palm of the hand, or bringing it towards the other fingers, is lost. On the back of the bone, just where it joins the wrist, there is a distinct projection, not nearly so large as it would be if the joint were out, and rectified at once by pressure, only as soon as the pressure is removed it returns again, with a visible and painful jerk. If the two hands are compared together the length of the bones corresponds exactly, so that it does not look like a fracture; it cannot be a complete dislocation, and a partial one from the structure of the joint is impossible. In reality the injury partakes of the nature of both. There is an oblique fracture through the base of the bone, where it joins the wrist, splitting off that part which lies deeply buried under the muscles of the ball. It does not involve the back of the bone, so that the measurements are unaltered, but owing to its carrying away with it the projection on the palmar surface that serves to make the joint secure, the rest of the bone slips back and sticks up under the skin. The crepitus, when pressure is made from front to back on the ball of the thumb, and the broken

surfaces are rubbed together, can be felt quite easily, and the pain is greatly increased thereby. The ultimate deformity, if the injury is not diagnosed, is not so serious as might be imagined, but the movement of the joint is interfered with for a considerable length of time.

CHAPTER IV.

NATURE OF THE INJURY.

SPRAINS differ a great deal both in the nature and extent of the injury. Sometimes it appears to be quite trivial; there is merely the slipping of a disc of cartilage from between two bones, or the displacement of a tendon from its groove; sometimes everything that holds the two joint surfaces together, with the exception of the skin, is torn and lacerated as it is in a dislocation. In many cases the injury is really as great: the bones are wrenched apart from each other at the moment of the accident, only instead of being caught and held, as they are in a dislocation, they fall back again of themselves into their natural position. Such accidents are always called sprains; but the tissues suffer as much as if the joint had really been put out.

The extent to which the tissues are torn at the moment is not the only thing that has to be taken into consideration. The symptoms and the after consequences are often most serious when this is apparently but slight; and the liability to inflammation, and other troubles, depends a great deal more on the constitution of the patient, and the way in which the sprained joint is treated, than on the number or size of the structures that are torn. So long as the natural process of healing is still in its full vigor, as in children and young adults, injuries, no matter how serious they are, are repaired without the least difficulty. The treatment must be well planned, it is true, and thoroughly carried out; proper care must be taken that the parts are not subjected to too severe a strain before they can stand it; but if this is done, after consequences of any kind are the exception. Unhappily as time goes on the effects of age and of constitutional frailties become so powerful that in many cases, in spite of every care, a comparatively trivial injury often leads to the most serious results, and re-

covery is delayed indefinitely, or remains imperfect perhaps for the rest of life.

Opportunities for examining joints shortly after they have been sprained are not very common, though they occur sometimes when a patient has received other and more serious damage in the same accident. By taking advantage of these a fair amount of information has been obtained with regard to ordinary cases; and the results have been confirmed by Bonnet, of Lyons, and others, who have made use of other methods. Many special sprains, however, such, for example, as the internal derangement of the knee-joint, first described by Hey, are still involved in a certain amount of obscurity. They are not uncommon; for years past they have attracted an unusual amount of attention from the inconvenience they cause, and the striking character of the symptoms that attend them; but the joints in which they occur are so complicated, and opportunities for examining them so rare, that there is not as yet any settled opinion as to what the nature of the accident may be. It does not seem unlikely that the actual displacement varies in different cases, even though the external symptoms are to all appearance the same.

Generally speaking, the tissues on one side of a joint are overstretched and torn; those on the other compressed and crushed together; but there is always so much twisting, and such a difference in the strength and power of resistance of the various structures, that unless the part is examined with the greatest care it is almost impossible to say what actually has given way. In every case no pains should be spared to find out the whole of the mischief with as little delay as possible. There are many instances on record in which delayed convalescence has been due solely to the fact that a displaced tendon or other structure has not been recognized sufficiently early. The difficulty increases with every minute. Immediately after a sprain, before the position of the parts has been altered by attempts at movement, or concealed by swelling, the nature of the displacement may often be recognized without much trouble. But if the chance is lost, the part begins to throb with pain, swelling sets in and obscures everything, and it is often necessary either to place the patient under an anæsthetic or to wait until the extravasation and œdema have been dispersed.

Hæmorrhage into the Sac.—Most of the swelling that makes its appearance immediately is due to the blood that pours out from the torn vessels. The central cavity of the joint becomes distended with fluid, which varies in character and amount according to the number and size of the vessels in the injured part, and the length of time that has elapsed since the accident. If the swelling reaches its maximum within the first few hours, it is probably due mainly to blood; if twenty-four hours pass by before this, there is a large proportion of lymph mixed with it, and, at the same time, if the joint is superficial, some heat and redness of skin. The amount is very variable; sometimes it is not easy to detect any increase at all; at others, especially if no steps have been taken to check it, the distention is so great that the outline of the synovial sac may be traced distinctly beneath the skin. The delicate structures lining the cavity are torn and bruised, and the vessels continue to bleed until the contraction of their walls and the pressure of the fluid accumulating round them stops the flow. Probably the blood soon coagulates, as it does when extravasated into other tissues of the body; and at a somewhat variable period becomes liquid again. At least, if a joint is tapped or aspirated a few days after a severe sprain, it is found to contain a fluid, which, though it still reddens on exposure to air, differs from blood in color, and in being turbid from floating *débris*. If left to itself, the quantity diminishes, and it undergoes other changes. The coloring matter slowly soaks into the tissues round, so that they remain deeply stained for weeks; the floating fragments become finer and finer, until they, too, disappear; and at length, though the amount remains excessive for a considerable time, it assumes again the character of the natural synovial fluid.

The rent in the capsule may be almost imperceptible, merely a superficial line, extending across part of the cavity, and only marked by an uneven band of discoloration; or it may stretch right across from one side to the other, and open up the cellular spaces round. It is especially liable to give way along the line of its attachment to the bone, and as this is where the blood-vessels are largest and most abundant it accounts in some measure for the amount of the hæmorrhage. At this point there is a considerable thickness of soft loose tissue with little resisting power, and the fibres are more widely spread

out and separated from each other than they are elsewhere, so that when a strain falls on them it attacks them, as it were, in detail, and easily overcomes them. It is very unusual not to find some evidence of violence, some staining or reddening at this point, after a joint has been sprained.

Hæmorrhage in the Synovial Wall.—The extravasation is, however, not limited to the interior. If the cavity is opened there are patches of it, apparently adherent to the inner wall, but really situated within its substance, covered over by so delicate a film of tissue that they can be plainly seen through it. Most of these disappear at length. They merely leave a thickened and discolored spot, which, as a rule, is well out of the way, and causes no inconvenience. If, however, they occur in a part of the joint where the lining membrane is loose and thrown into folds when at rest, or where there are many fringes and outgrowths well protected from pressure, as round the neck of a bone, they sometimes lead to great annoyance. A hard, unyielding patch is formed in the smooth and supple wall; its flexibility is lost, and it cannot yield itself kindly to the movements of the joint, but drags on the other parts, and acts as a continual source of irritation and pain.

These changes are not confined to sprains; they occur after other injuries with almost equal frequency, and may always be suspected when, long after an accident, some particular or unusual spot remains tender, or one special movement is limited in extent. They are particularly common in the deeper layers. The soft cellular pads that are developed in and round joints, for the purpose of filling up spaces that vary in size with every movement, are generally deeply stained with blood. If this is absorbed again no ill result follows; but it often happens, from the soft and yielding nature of the tissues at these places, and from the way in which they are protected from pressure, that when a joint is kept at rest in one position this is never thoroughly carried out. The blood remains for a long time without changing, and then slowly becomes organized into a dense, unyielding mass. The pad which was intended to give way before the faintest pressure, and accommodate itself to every change of position, becomes hard and dense, and moulded to one form. So long as the limb remains at rest it is fairly comfortable; as soon as it is moved there is pain, because the pressure is no longer distributed evenly over the whole surface.

Bursæ.—Changes of a similar character are very prone to occur where there are spaces near joints, in which blood or other fluids collect after injuries. They may be bursæ or mere interspaces in the cellular tissue, without any well-marked limit; some are definite in shape and position, existing, at least in adults, in all alike; but many are accessory, developed here and there by the accidental friction of one structure on another, and, therefore, differing in size and shape and position in each individual. Whatever they are, they act as receptacles for the blood which is extravasated into the tissues after sprains and other injuries. It collects in them and distends them, lining their interior with a layer of false membrane, which slowly becomes organized and makes their wall dense and hard. Then they become tender and painful; their surfaces are roughened and irregular; they obstruct instead of assisting the movement of one part on another; and often, by inducing the patient to keep the part at rest, they lead to other changes, the importance of which is altogether out of proportion to the severity of the original injury.

Some of these bursal swellings are very perplexing. In many cases where there is a large cavity overlying a joint it is very difficult to tell whether the fluid is really in the synovial sac of the joint or outside it. It may reproduce the shape exactly, and by its tension prevent the muscles from contracting as much as if the capsule itself were distended.

In others, especially when the swelling is recent, and there is something firm behind, such as a bone or the wall of the chest, the imitation of a fracture is surprisingly good. There is a sensation of crackling, when the part is handled, closely similar to that produced by rubbing together the two ends of a broken bone. It is really due to the dense fluid being pressed through the meshwork of connective-tissue interspaces which make up the interior of most of these; and it may nearly always be distinguished (independently of the absence of the other signs of fracture) by the difficulty there is in eliciting it a second time, until either the fluid is driven back again or some more allowed to accumulate. There is no difficulty in feeling it once, but it is very hard to demonstrate it to another person.

When extravasated blood collects in the space between the shoulder-blade and the back the sensation is most deceptive.

I have known many instances in which a mistake has been made through relying on this, fractures of various parts of bone having been diagnosed, in spite of the absence of displacement and of tenderness on pressure. This occurs, too, in other situations. In one case in particular the patient, who had on a previous occasion suffered from several fractures in different parts of his body, was so firmly convinced that his collar-bone was broken that nothing could make him believe the contrary. He had sustained, certainly, a severe fall on his shoulder, and was badly bruised; there was great difficulty in raising his arm from the side, and the whole region was much swollen; but there was no displacement of any kind, and the tenderness was general, not limited to any one definite spot, as it would have been in the case of a fracture. On manipulation, however, the most distinct crepitus would be obtained, especially when the arm was lifted up, and the shoulder grasped firmly from before backward by the finger and thumb; and it was so definite in character, and so perceptible to the patient, that he was absolutely sure that it came from his collar-bone. Not until ten days had passed, when he could use his limb freely in all directions without pain, would he admit that the fracture (if it was one) had united very much more rapidly than those he had sustained on a previous occasion.

In this case there was undoubtedly a large extravasation of blood into the bursa which covers in the shoulder joint. Very likely its walls were torn, or crushed and bruised with some of the muscular fibres lying over it. Raising the arm pressed its sides together, so that the fluid was driven from one part to another, and squeezed among the irregular meshes that lined the interior. Later on this was absorbed; the staining made its appearance in the usual situation, under the borders of the deltoid, and as there was no permanent thickening or rigidity of the walls, movement was completely regained. All cases are not so fortunate. It is not uncommon to find the interior of this bursa lined in all directions with shaggy villous projections, hanging down in the cavity, the result of repeated injury or inflammation, and the cause of constant inconvenience and even pain.

The Ligaments.—The extent to which the ligaments are injured varies quite as much. It is no uncommon thing to find the strongest in the body, such as the internal lateral

ligament of the knee or ankle, completely torn across, and the joint as full of blood as it can be; or, on the other hand, there may be scarcely a bruise or tear. They are really part of the capsule uniting together the ends of the bones. The structure is the same in all essential particulars, and they are practically continuous; only the arrangement is different; in the one, the fibres are scanty and weak, with many and large inter-fibrillar spaces; in the other, they are arranged in closely woven bundles, parallel to each other, and so tense as scarcely to admit of any elongation by sudden violence. They may tear, especially small portions of them here and there, so that the whole thickness is not broken across at any one spot; but they will not stretch. It is true that under certain conditions they do become elongated, but this only happens when the strain is continuous, and lasts for some considerable time. A slight degree of inflammation sets in then, and under its influence the fibrils soften until they yield

Sometimes ligaments give way in the middle, but it is more common for them to separate from the bone, or to wrench from it a small thin scale corresponding to their attachment. This is due in part to the arrangement of their fibres. In the centre they are woven closely together, and form a rounded bundle of great strength; at the ends they spread out like a fan, so as to secure a wider attachment. By this their mutual support is lost, and the course of the fibres is altered, so that the direction of the strain no longer coincides equally well with that of all the strands. Owing to this they give way much more easily. A ligament that can resist successfully a straight pull of great violence yields at once to a twisting force of much less severity, because this falls on the fibres unequally, one by one, and tears them from their attachment.

Intra-articular Ligaments.—Some of the structures that lie in the interior of joints occasionally suffer in a peculiar manner. Inter-osseous ligaments, formed of very short numerous bands of fibres connecting immediately two roughened bony surfaces, rarely give way, owing to their great strength, the bone yielding instead; but the discs of fibro-cartilage, which are interposed in places between the bones for the purpose of deepening the sockets, and modifying the effect of shocks, are very liable to suffer. Sometimes they are bruised or crushed; more often they are torn from their attachments

and displaced, so that they interfere with the working of the joint. Or, without being actually separated, they may be so stretched that the result is much the same. This is best known in the knee; in other joints in which discs of this kind are found they are so much smaller and so firmly fixed that they rarely give rise to any inconvenience. In the knee they are very large; their normal range of movement is very considerable, and they are so loosely held that displacement is not only easy, but, when it has once been produced (owing to the feebleness with which repair takes place), is always liable to occur again.

The Knee.—I am not aware that there has ever been an opportunity for examining the interior of a knee joint shortly after this had happened for the first time, and before the disc has been replaced. Indeed, from the nature of the accident, it is scarcely likely there could be such, except under the strangest coincidence; but on several occasions the joint has been opened and the displacement verified after it has occurred repeatedly. And often the patient is aware of a projection from the side of the knee, caused by the displaced disc. There is, therefore, no question as to the nature of the accident, but, as has been already mentioned, it is by no means certain that this explanation serves for all the various forms of internal derangement that have been described, even when full allowance is made for the different directions in which it may take place.

The Fingers.—The finger joints, again, are the seat of a peculiar kind of injury somewhat similar to this. They all of them belong to the class of hinge-joints, admitting free movement so far as flexion is concerned, but exceedingly little in any other direction. On the under surface of each there is a plate of fibro-cartilage, similar in structure to the discs in the knee joint, and, like them, helping to deepen the socket in which the head of one bone rotates. In fact, this is the chief bond of union between the bones, but while it is so firmly united to one that it is almost impossible to tear it off with any reasonable degree of force, the fibrous tissue that binds it to the other is soft and flexible, so as not to interfere unduly with the action of the joint. Sometimes it happens in severe wrenches, especially when the finger is forced backward, that this plate of cartilage is torn from its attachment, and slips

up between the bones, so that when the force is past they cannot resume their natural position.

Mitchell Banks has shown how this occurs in the joint between the index finger and the hand, in which it is most common; and I have met with several instances, not only there, but in other joints also. It is an exceedingly painful accident, often causing fainting and sickness. The deformity is very conspicuous, especially in the back of the joint, though it is not so great as that of a true dislocation or when a bone is broken. The finger is kept slightly bent. By using the other hand the patient can move it through a considerable angle, but he cannot either straighten it out or bend it thoroughly into the palm. No amount of force produces any effect in the displacement; it is due to the cartilage which has slipped between the ends of the bones and prevents them moving freely on each other. Until this is released from its position the deformity must remain unrelieved. If left to itself the finger generally recovers a good deal of its power, but the appearance is very unsightly.

The Muscles.—The muscles round joints rarely escape when the sprain is severe, though the injury may at first be masked by other symptoms. Sometimes it is very serious, but this depends probably on their condition at the moment of the accident. If they are firmly contracted and ready to resist, the joint does not suffer unless they are overcome, and then the injury is generally too great to be called a sprain. Most often they are taken by surprise, and are hurt more by their own sudden and spasmodic effort at recovery than by anything else.

The weakest part of a muscle varies a good deal according to its shape. When they are short and broad, with wide attachments to the bones and firmly bound down by sheets of fibrous tissue, there does not seem to be any definite rule. Probably the part that gives way first is determined mainly by individual peculiarities of structure; but when they are of considerable length, and attached to distant bones by rounded tendons, the weakest part is the line of junction between the muscular fibres and the connective tissue. It is at this point that they tear, causing a great extravasation of blood, and giving rise to a swelling which at first is soft and fluctuating, but which soon becomes hard and solid, and may persist in that condition for an almost indefinite period.

This often happens when the fibres are torn across, while the dense unyielding sheath that surrounds them remains intact. The extravasated blood is tightly bound down, and forms a hard resisting nodule, the nature of which can only be ascertained by the rapidity with which it occurs and the way in which it is confined to the limits of the muscle. I have recently had under my care a patient with a nodule of this kind in one of the muscles of the neck just where the tendinous and muscular fibres meet. It made its first appearance quite suddenly during a violent effort, with all the characteristic signs of muscular rupture, more than a year before, but in spite of energetic treatment by massage and other methods it was nearly three months before it finally disappeared.

When a muscle gives way completely, it is usually at the same spot. A curious instance of this is not uncommon among butchers. They occasionly lose the last joint of their thumb by catching it in a hook and tearing it off. The skin and the ligaments give way at the seat of injury, but the tendons of the muscles retain their connection with the bones. The long flexor is pulled out of its sheath for five or six inches, one end remaining attached to the bone, the other bringing away with it torn shreds of the muscular fibres that have given way above the wrist.

Rider's Sprain.—Sometimes the muscles are torn and strained without the joints being hurt at all. Those, for example, that lie on the inner side of the thigh occasionally give way under the semi-voluntary grip by which a rider secures his seat when his horse swerves or bolts round. There is a sudden sharp contraction, a sensation of something giving way, and a feeling that the hold on the saddle is gone. A dull aching pain sets in at once, and grows worse and worse with every attempt to proceed; the part begins to swell as the blood pours out from the torn vessels; a peculiar warm trickling sensation is felt down the inner side of the leg, and, as a rule, the rider is compelled to dismount. When standing, the symptoms are not quite so severe, but the least attempt to bring that group of muscles into play again, or to remount, makes them tenfold worse.

The kind of injury is well known, and is usually recognized at once. It is due to the rupture of the tendon that stands out under the skin on the inner side of the thigh; sometimes it

gives way near the bone, so that the gap can be felt, but more often the muscular fibres are torn away from it without leaving any distinct interval. The extravasation is often very extensive, and it may be weeks before the last traces of the staining finally disappear. Every endeavor must be made to keep it as much as possible within bounds. A stirrup leather may be tied tightly round the part as a temporary measure; but a much more effectual method is to buckle a long strap of webbing round the thigh, outside the breeches. It must be well padded, on the inner side, over the point where the muscle is torn, and coming up in front and behind, should cross over the hip and be carried round the waist. Where the laceration is complete, some such appliance may be permanently required.

Rider's Bone.—A long slender spine of bone which is occasionally met with in connection with these tendons probably has its origin in the same kind of injury. It is known as rider's bone, from its being found chiefly in those who have spent a large proportion of their lives in the saddle. Sometimes it causes a good deal of inconvenience by the way in which it interferes with the flexibility of the part; but more often its existence is hardly known, as it lies buried in the substance of the tendon itself. If the history is inquired into, it is always said to have developed after one single severe strain; but comparing it with similar formations in other tendons, it seems more probable that it is due to the constant bruising to which the muscles are subjected. Probably it is formed from the organization of lymph thrown out from time to time.

Rider's Bursa.—Other troubles also are produced in this way. A soft fluctuating swelling sometimes makes its appearance underneath the tendon, high up in the groin. So long as the muscle is in action it is tense and firm; as soon as it is relaxed it becomes soft and flaccid; but it cannot be dispersed, or even reduced in size, by pressure. In one case under my care, considerable improvement was effected by rest and blistering, but I am afraid it was not permanent. The patient was a man who had been accustomed to a great deal of rough riding, and it seemed to cause him considerable annoyance. The thing of which he complained most was a sensation of weakness, similar, apparently, to that which is so often experienced in the hand when there is a ganglion on the back of the wrist; but it was doubtful if there was any actual loss of

power. The swelling had made its appearance slowly, and was still increasing when he came to see me, so that it evidently was not due to any extravasation. Most probably it resulted from the effusion poured out after repeated strains; and, as he could not give up his occupation, it is certain to increase, until it ends either in inflammation and suppuration or else in the formation of a bursa.

Lawn Tennis Leg.—Lawn tennis leg is another instance. This was a well-known form of accident long before lawn tennis was ever played; but it has become so much more common, as the game has grown popular, that perhaps the name is not inappropriate. It is most frequently met with in men, especially in those who, as youth passes by, are beginning to increase in weight, and whose muscles are somewhat out of training; but not improbably there are other causes too. It is decidedly rare, for instance, among the laboring classes; I am not aware myself of having seen any example among the out-patients at hospitals; and, whether it is worth anything or not, it is certain that in a very large proportion of the cases some evidence of gout may be found, not necessarily of any very acute attack, but merely of those indefinite forerunners which are often quite as distinctive. Generally speaking, it occurs during some sudden and violent effort, a sudden spring forward to take a ball, for example; but the merest slip is enough. Indeed, in some cases it is so difficult to obtain a definite history of such an accident that I am rather sceptical as to its really being required. I have known at least one in which it occurred while the patient was walking along a level road, on which there was not even a projecting stone.

The symptoms are exceedingly characteristic. All of a sudden there is a sharp stab of pain in the calf of the leg; the patient stops instantaneously, lifts his foot from the ground, and nearly always looks round to see if some one has not struck him a violent blow with a stick or a stone. Rest his weight on the leg he cannot; the pain, it is true, does not continue with the same intensity, but the recollection is such that nothing will induce him to try. When the part is examined, there is generally nothing to be seen; but there is an exceedingly tender spot in the substance of the calf, and sometimes a slight depression can be felt. Later on, marks of bruising make their appearance, yellow at first, but gradually becoming darker as

the coloring matter approaches the surface, and, generally speaking, most plain toward the lower part of the leg, even when the painful spot is nearer to the knee. This, however, is liable to be modified considerably if the part is well bandaged. In one or two cases I have noted a slight degree of puffy swelling behind the ankle, and it is said that occasionally the foot is deflected somewhat from the straight line; but this I have never seen myself, and I should feel inclined to assign it, when it is present, to secondary changes taking place in the smaller joints of the foot, consequent on the very unequal and unfair degree of strain thrown on them.

The usually received explanation of this very striking accident is that it is the result of the rupture of an exceedingly small muscle, known as the plantaris, situated in the substance of the calf of the leg. The muscle itself is in many respects most peculiar; it is very deeply placed, lying under the largest muscle of the calf, is itself exceedingly short and weak, being rarely three inches long, and is provided with a prodigiously long tendon, which either joins the tendo Achillis at the back of the heel, or else is attached to the bone in close proximity to it. Whether rupture of such a structure can take place or not is almost impossible to prove; the fact is commonly asserted, and it is usually admitted as an explanation of the symptoms, but I am not aware of any instance in which it has been actually shown. It is quite certain that the same effect may be produced by other causes.

This explanation, for example, does not answer when the same accident occurs twice in the same leg at different places. A striking instance of this recently came under my notice, the interval between the two occurrences being only a few weeks. On the first occasion the middle of the calf of the leg was the part involved; on the second it was at least four inches lower down, and nearer to the ankle. Nor was this to be explained as the rupture of muscular adhesions that had developed during the period of convalescence; for not only had there been nothing to occasion them in this locality, but recovery was practically perfect, so that the patient could walk without inconvenience, and without any apparent limping. The second accident was precisely of the same nature as the first; there was the same sharp stab of pain, with tenderness, and a slight amount of swelling, and the same feeling that it was impossible

to place the foot upon the ground; but clearly it could not be due to the tendon. This, if it had united at all, could not have been sufficiently firm to withstand a strain that compelled it to give way at another part. The scar could not have been so strong as the original structure.

W. Hood (Lancet, 1884) considers that it is the result of the rupture of some portion of the muscular or tendinous structure of the calf, without specifying it more particularly; and no doubt this is correct in many instances, especially when a depression can be felt by the finger where the fibres have given way. Rupture of the plantaris, which is comparatively a deeply-seated muscle, could never cause this. I would venture to suggest, however, that, in those cases at least in which the amount of blood extravasated is considerable, the cause is connected with the condition of some of the deep intermuscular veins. In many instances they are unusually large; they become varicose, nearly to as great an extent as the superficial ones, and there is no doubt that sometimes they give way, or become blocked by the development of coagula in their interior. This naturally causes very severe pain, owing to the way in which the nerve-fibres are stretched or compressed; and unless absorption is completed very soon, is sure to leave behind a considerable degree of stiffness. The degree of pain that is caused by the rupture of a small vein, especially when the extravasated blood is bound down by surrounding textures, is something surprising so long as it lasts.

The method of treatment to be adopted in these cases is admirably described by the same writer. He recommends that as soon as possible after the accident the patient should be placed in the recumbent position, with the injured leg raised above the level of his head, and should be kept in this position for five minutes. This is very important for two reasons. In the first place, the leg is emptied at once of all superfluous blood, so that the swelling soon goes down. When a limb is raised in this fashion the artery contracts; much less blood flows to it, and the veins are so rapidly emptied that if a superficial one has given way this alone is sufficient to stop the bleeding. The calf, which is enlarged and hard, returns to its normal size, and the patient at once obtains relief from the distressing feeling of tension. But besides this, if the elevation of the limb is neglected, the plaster next to be described is

loosened by the subsidence of the swelling, and requires to be replaced in a few hours. He then advises that while the leg is still raised strips of adhesive plaster, each an inch and a half in width and of length adapted to the size of the limb, should be applied from two inches above the ankle joint to above the thickest part of the calf, somewhat as strapping is applied in the treatment of chronic ulcers of the leg. As soon as it is applied the patient should be directed to walk about the room, and to place the heel firmly, or at least fully, on the ground at each step. For the first dozen steps he will probably hesitate, and will retain more or less of the limp with which he entered; but after a short time, finding that his pain is diminished or possibly removed, he will gain confidence, and will walk with a pride in his own performance which is very interesting to witness. This description is exceedingly accurate:—"Until this point is reached he should not be suffered to depart; for, if he does not walk properly before he leaves the surgeon, he will hesitate still more when alone, and will be likely to return to the ungainly progression which he exhibited at the commencement of the interview. Success in walking, in the first instance, will depend largely upon the temperament of the injured person. A resolute man, who believes in his doctor, will walk at once, while a more timid patient will require coaxing and urging. The chief trouble will be with the sceptical man, who has his own 'views' about the injury, and who will express them in such questions as, 'Well, but do you not think there is a risk of inflaming my leg?' 'Shall I not make the internal wound larger?' and so forth. With reasonable care neither to jerk the leg nor to twist the ankle on uneven ground, the patient, as soon as the plaster is applied, may walk about as usual. By the third day the plaster will be somewhat loose, and the patient will say that he is not quite so comfortable as before, and is less inclined to trust his leg. The strapping should be reapplied, and he will at once feel more secure and better able to walk. Four days may elapse before the next strapping, which may be left untouched for a week, but the application should be continued at intervals until the patient is quite convinced of his ability to do without it. On the first occasion very little pressure is desirable, and mere laying on of the plaster will be sufficient. Subsequent strappings should be tighter, but never

so tight as to produce a sense of unpleasant constriction, a rule which must be especially borne in mind in applying the first and last piece. The amount of walking should be increased daily, and after the third day the patient should go up and down stairs freely in the usual manner. Until then his ascents and descents may be infantile."

I would only add that in those cases in which I believe the real cause to have been the rupture of some deep-seated varicose vein, I have found the above-mentioned method of treatment as successful as when the muscular fibres were plainly torn. In other parts of the body partial rupture is equally common. Sometimes only the sheath of fibrous tissue that surrounds the muscles gives way; the soft tissue is squeezed out through the rent, and so tightly constricted at the opening that it becomes forced into the shape of a mushroom. I have seen this in the extensor muscle on the front of the thigh. It was attributed at the time to the fact that the patient received a violent blow on the spot from a blunt piece of iron at the moment of vigorous contraction. The symptoms, however, were not well marked, and as recovery was complete without further inconvenience than a small depression in the substance of the muscle, nothing further was seen of it.

Many other tendons occasionally give way during great exertion. Even the stoutest, such as the tendo Achillis, may be torn across, though it is more common for the bone or the muscle to yield instead. I have in my possession a shoulder joint in which the long tendon of the biceps has been ruptured about an inch and a half from its attachment to the bone, so that the end projects into the cavity of the joint. The other part has formed for itself a secondary attachment on the floor of the groove in which it normally lies. Similar changes have been described from time to time in connection with many others.

Dislocation of Tendons and Muscles.—When the injury falls short of actual rupture it may still be very severe, and lead to a great deal of after trouble. Tendons, for example, where they cross a joint or run over a projecting process of bone, lie in grooves, which are lined with a delicate sheath similar to that in joints, and this rarely escapes. In slight cases it is merely bruised where the tendon presses against it, but it may be filled with extravasated blood, or be torn open

down the whole of its length, while the tendon escapes and lies displaced among the adjacent tissues.

In the Back.—Both muscles and tendons may be dislocated in this way. Callender and others have shown how this happens where long and slender slips lie embedded among shorter and stronger ones, as in the back and some parts of the limbs. The muscles are closely packed together, surrounded, and at the same time separated from each other, by fibrous tissue, which is dense and firm toward their ends, soft and yielding at their centre. In all ordinary movements, carried out in an orderly fashion, with a definite object in view, the action spreads, as it were, from one muscle to the next. Very few are carried out by the contraction of a single one. Nearly all involve not only those immediately necessary, but those also by their side, which are more or less parallel in their course. The shape and consistence alter together, so that their mutual relations remain unchanged. When the contraction is sudden and spasmodic, it sometimes happens that one of these slips from its bed between the rest, tearing its fibrous sheath, and becomes displaced or dislocated. Probably this is due to the irregular and disorderly fashion of the contraction. There is a sudden pain, quite local, but made worse by any movement that would call that muscle into play, sometimes so severe that such movements cannot be executed at all. The surface of the skin is slightly raised if it is superficial, and nearly always there is considerable local tenderness.

These symptoms are, it is true, very nearly the same as those of partial rupture, which is a great deal more common; but there is no question that dislocation does sometimes happen, as complete and almost instantaneous recovery takes place as soon as it is reduced. In some instances the patients have actually felt the muscle slip back into its place again; and in a few it has been known to slip in and out again and again, owing to incautious movement at a too early period.

The Sartorius.—Large muscles, too, are occasionally displaced. A remarkable case has been recorded in which the sartorius was detached from its position on the inner side of the knee by an accident of this kind. Just before its attachment to the bones of the leg, this muscle gives off from its border a tough fibrous expansion to the capsule of the joint. This was torn across, and the muscle itself displaced. The

accident befell a man who was squatting on the floor of a wagon in the position assumed by tailors. A companion tripped over him and fell across his knees; something was felt to give way near the ham, and on examination the above mischief was made out. In another instance under my own care, after a somewhat similar accident, there was much tenderness, and a soft ill-defined swelling over the inner side of the knee for a considerable time; and all the movements that require the assistance of this muscle were very painful, as if some of its fibres had been torn across.

Peronæi Tendons.—The tendons of the peronæi muscles, again, are not unfrequently displaced from their position behind the outer ankle. The sheath that confines them in their groove is torn down its whole length, and they slip forward on to the bone. In the two examples that have come under my immediate notice, neither of the patients was sufficiently trained in accurate observation to give a reasonable account of the way in which the accident occurred. It is not hard, however, to conjecture the direction in which the foot must have been twisted for such displacement to be produced. One of them had sprained the same joint already several times before, and although the tendon had never been completely displaced, it is by no means improbable that the constant repetition of the injury had caused the sheath to stretch until it became too weak to resist. It is possible, too, that the groove in the bone had become partly filled up by the lymph thrown out. In neither was there the least difficulty in reduction; but while this was successful and permanent in the case of the one, in the other the least movement caused them to slip over the bony margin again, confirming my suspicion that the mischief was not due to one accident only. Bandaging, strapping with pads in all positions, fixed apparatus of many kinds, complete rest, with the foot kept at a right angle for weeks together, all were of no service. Gradually the inconvenience became so much less that the patient would not submit to any further treatment. At first, each time they slipped forward there was the peculiar sickening pain common to all overstretched fibrous textures; but soon this, too, ceased to be felt, and the patient having had no arch to his foot for some long time before, the comparative loss of these muscles was not so serious to him as it otherwise would have been.

On the Hand, etc.—Other tendons do not so often suffer in this way. Paget has described displacement of some of the extensor ones on the back of the wrist; but though a slight degree of slipping and yielding at this point is very common, complete dislocation rarely happens, probably because the direction in which they run deviates so little from the straight line. In bad cases of knock-knee, the knee-cap lying in the tendon of the great extensor often slips to the outer side of the joint when the limb is straightened; and the same thing sometimes occurs during flexion, from defective development of the lower limb, associated with a peculiar kind of deformity; but neither of these can be fairly regarded as dislocation of a tendon due to injury

Biceps.—Whether the long tendon of the biceps can be displaced from the groove in which it lies seems still not quite certain. I have seen one case in which this peculiar injury was diagnosed, and although verification was not possible, I think there can be no doubt not only that the tendon did actually slip out of its bed, but that by twisting the arm round, which the patient could do by means of his other hand, it could be made to slip in and out again at pleasure. No snap could be heard, it is true, nor was there any distinct difference along the front of the arm when the two sides were compared together; but the inability to raise the arm from the side at one moment, and the comparatively free range of action after reduction had been effected, left little doubt that it was a genuine example. Passive motion was fairly good, as it was in the case described by Hamilton, only somewhat painful. There was no undue prominence on the front of the shoulder, possibly because of the recent date of the accident. The case, it is admitted, is incomplete, and as the patient was under my observation only a short time, I cannot give any account of the subsequent progress. It does not agree in all respects with those recorded; but as Hamilton has shown by actual dissection the possibility of such an accident, and as I cannot understand what other displacement in the region of the shoulder could have produced so peculiar a train of symptoms, sometimes well marked and definite, and then all of a sudden disappearing for a time, I think it must be allowed. In old cases of rheumatic gout it is not at all uncommon to find the groove filled up, and the tendon flattened out over some ad-

jacent part of the head of the bone, but there was no evidence of disease in the present instance.

Ruptured Veins.—The presence of varicose veins is often a serious matter when the ankle joint is sprained, particularly in the case of a person who is advanced in life; and in this respect minute vessels, which give rise merely to a mottled bluish appearance of the skin, are, perhaps, more to be apprehended than when one or two of the larger trunks only are involved. The actual amount of blood lost may not be so great, but the tissues do not seem so well nourished, and absorption is much more slow. It must not be forgotten either that the deep intermuscular veins are often as much dilated as the more superficial ones, and that when they give way a very large quantity of blood may be effused into the deeper strata of a limb before making its appearance on the surface. The inconvenience that results from this is very serious, and convalescence is much protracted; for until the whole of the blood thus effused is absorbed the muscles do not recover their freedom of action, or the subcutaneous tissues their normal supple feel. Rigidity and œdema, worse when any exertion is made, may persist for months solely owing to this.

Injury to Bones.—This even does not exhaust the list of structures that may be injured. The bones themselves are frequently bruised, especially when, either from delicacy of constitution or other causes, such as disease, their substance is soft and vascular with an undue amount of fat in their composition. It is true these injuries are not often demonstrated, though I have sometimes found dark stains, due to hæmorrhage, deep in their substance; but inflammation is sufficiently common to make it unreasonable to doubt that they too meet with their share of damage. Diseases of the spine, hip, and other joints in children may be due, in great measure, to some constitutional taint, though it is open to question whether the influence of this is not overrated; but it is quite certain that the immediate starting-point in nine cases out of ten is some chance sprain, often so slight as scarcely to have been noticed at the time.

CHAPTER V.

INFLAMMATION AND THE PROCESS OF REPAIR.

THE changes that take place in the tissues after the immediate effects of the injury have disappeared cannot be allowed to pass without some degree of notice. It is true that there is little that is special or peculiar about them; they are in nearly all respects identical with those that follow fractures or other injuries; but, for some reason or other, it is the popular impression, one that is shared, too, by not a few medical men, that these accidents are almost invariably followed by acute inflammation. Imperfect recovery is, I admit, exceedingly common; it is the frequency of it which makes sprains so serious; but, rightly or wrongly, inflammation is nearly always regarded as the cause. If it is the case, it is only reasonable that it should be allowed a certain amount of influence on the kind of treatment adopted.

At first sight, I am bound to confess, much apparently may be said in favor of this opinion. There is nearly always present in these cases a cavity of some kind or other, whether it is a joint, sac, bursa, or tendon sheath; and this is certain to be distended under considerable pressure by blood or lymph, which, unless active measures are taken, is very slowly removed by absorption. The quantity that may collect in a few minutes is enormous; I have on many occasions seen the wrist double the circumference of its fellow within half an hour of an accident. Naturally the degree of tension is very considerable; the sensory nerves are stretched or compressed; the part begins to throb; the skin becomes hot and red; and, to all appearance, there is the commencement of an attack of acute inflammation.

Now, there is no question that if this is allowed to continue unchecked it is very likely to be followed by this result; but if due and proper precautions are taken against it there need

not be the least fear. When inflammation breaks out, it is either the consequence of neglect, maltreatment, or some peculiarity of constitution, such as gout or struma, so marked that the least accident is sufficient to precipitate an attack. The changes that take place in the tissues after sprains are merely those necessary for the repair of the damage; it is only when they are encouraged beyond measure by other causes that inflammation is likely to break out.

Hyperæmia and Softening.—As soon as the bleeding is checked the vessels all through the injured area dilate, and their walls become relaxed and softened. The volume of blood circulating through the part is immensely increased; a much larger amount of liquid plasma pours out through the walls into the tissues round, mixing with the blood that has already been extravasated. All the interstices are filled with it, and become distended more and more, until the joint swells up and the skin becomes tense and shining from the way in which it is stretched. The different tissues are affected, of course, in different degrees; the capsule itself, owing to its delicate construction, very soon becomes thickened and softened; the loose tissue round it is affected even more quickly; the ligaments, from the way in which their fibres lie close set against each other, resist much longer; but they, too, at length, if the process continues unchecked, undergo a similar change, so that the softening and distention become general.

Effusion and Distention.—The fluid pours at once into any natural spaces, such as tendon sheaths or bursæ, that may be present. These and the synovial sacs of joints are the first to become distended, so that for some time the shape of the swelling follows distantly the natural contour of the part. Later, when the connective tissue round becomes softened and the swelling more general, this is lost, and the outline is rounded and uniform. At this stage the skin may be whiter than natural, though the temperature when the hand is laid upon it is higher than that of the corresponding point of the opposite limb; the superficial parts are so tensely stretched that the blood-vessels are emptied by the pressure, but the sensation of warmth is still transmitted from below.

Very little of this, of course, is to be seen post-mortem. No hyperæmia can be found then, no matter how great it was during life. It disappears with the vitality of the part, and

its extent and degree can only be conjectured from the few signs it leaves behind. Minute extravasations may be found here and there, especially among the softer parts; and the fluid in the cavities may be stained with blood in different degrees, or, it may be, turbid from shreds, and flakes of fibrin or mucus floating in it; but apart from the actual lacerations, nothing further can be seen in the earliest stages.

At a later period the changes are better marked. The smooth glistening polish on the inner lining of the joint is gone; in its place there is a dull and lustreless surface, stained and discolored by the blood, and coated over with a deposit similar to that which makes the fluid in the interior turbid. In recent cases this may be washed off; after a time it appears to be incorporated with the wall itself. The two cannot be separated, and if a small portion is removed and examined under water, a number of little gelatinous processes float up from the surface, so that it looks something like a piece of coarse velvet. This is particularly marked over the softer parts of the capsule, where the synovial membrane is thrown into folds, or where masses of delicate and vascular connective tissue project into the interior for the pupose of filling up the irregularities between the bones. On the other hand, where the ligaments directly bound the cavity, merely covered by a layer of cells, with no soft intervening stratum, hardly any such change is to be seen. So it is with the cartilage that covers the bones; it scarcely shows a trace; even the blood stains cannot penetrate beneath the surface.

Organization.—The softer and looser the tissue the greater the effect. Round the edge of the joints, so to speak, outside the line of pressure, where the fibrous capsule is attached to the bones, and where the synovial membrane lies folded on itself, and, as age advances, becomes covered over with fringes and villous processes, the bruising and softening are most conspicuous. It is not the surface, or the lining membrane only, that shows the change; the whole thickness of the capsule is affected, and where it is thin and delicate, or where, owing to the shape of the bones, there are hollow spaces round on which pressure never falls, the tissues outside suffer too. In more than one example I have seen this extend long distances by the side of the bones; and it is, I believe, in great measure owing to this that many sprains, apparently trivial

at the outset, are followed by such impairment of mobility. Unless measures are taken to prevent it, the whole of the fibrous structures at this part, the folds of the synovial membrane, the capsule, and the loose tissue outside it, appear to be lost in a soft, gelatinous mass of lymph, in which a few fibres here and there can still be found. If the joint is allowed to remain unmoved this fills up the entire hollow between the bones. Then, after the effect of the injury has passed off, when the hyperæmic stage is becoming less marked and repair is carried on more actively, it becomes organized, and converted into dense, unyielding, fibrous tissue, which ties the bones together, and to a great extent cripples the joint. It is not the fault of the synovial membrane alone, or the capsule, or the soft and loose connective tissue on the outside; they all play their part, though the share each of them takes may show a certain degree of difference in different cases.

In Joints.—In the shoulder, for example, stiffness of this description is of common occurrence, and may lead to serious inconvenience. At the lower and inner part of the joint the capsule is very thin, and has round it a large amount of loose fibrous tissue, so soft and delicate that it is thrown into folds when the arm is hanging by the side. No pressure falls on it so long as the limb is in the natural position; as it is raised from the side the folds are gradually straightened out, until they are put upon the stretch by the pressure of the head of the bone. Now, when the joint is sprained or hurt, this part of the capsule, owing to its softness and vascularity, is exceedingly likely to be injured; and unless active measures are taken to prevent it, the whole of it is very easily converted, first into a mass of soft, vascular lymph, and then into dense and unyielding fibrous tissue. There is nothing to prevent it. There is no pressure to close the vessels and limit the amount of lymph thrown out, or to help on the process of absorption; the folds are never opened out or separated from each other; if the joint is in the least degree painful it is kept at perfect rest, owing to the presence of others close by ready to undertake its work, and all the time without the patient being aware of it. When he is directed to raise his arm sideways from the body, he imagines he is using his shoulder joint, while, as a matter of fact, the whole of the action is being carried out by others; and this goes on until, by degrees, organization com-

mences, and the part quietly becomes stiff and rigid. The surfaces of the folds become adherent to each other, and incorporated with the tissue round; and instead of a soft and flexible capsule, there is a mass of shortened, rigid, and unyielding fibrous tissue, matting everything together, and not only by its strength preventing proper movement of the bones, but, by the pain it causes when any attempt is made, preventing any vigor being thrown into it.

Between Muscles.—Similar changes take place in the planes of the soft, cellular tissues that surround muscles, lying between them and other structures. The blood, escaping into these from the torn vessels, makes its way along the line of least resistance until it reaches some part where there is no pressure or movement. Here it remains, passive and unchanged, for a considerable period; but at length it slowly becomes organized, and by gluing together the different strata, gives rise to the stiffness and loss of power that are so common after severe muscular strains.

In Bursæ.—The effect produced by large bursæ has been already mentioned in speaking of joints. Many of them are merely open spaces in the connective tissue, lined by a single layer of cells, and, in ordinary circumstances, contain merely sufficient fluid to enable one surface to glide freely and smoothly on another. In reality they are formed, as required, out of the intercellular and interfibrillar spaces that exist everywhere in connective tissue. After sprains they act as receptacles for blood and lymph, and often become immensely distended. If the fluid is quickly absorbed again there is no ill result; the walls contract, and the cavity resumes its former size and shape; but if there is any delay when at length absorption does take place, the softened and relaxed walls are thrown into folds, so that the sides grow together and become incorporated with each other. Instead of there being a thin-walled sac, assisting every movement by diminishing friction, there is a rigid mass of tissue, stiffened, irregularly thickened, and adhering to everything round it, the seat of constant pain and tenderness. When this change is established, restoration is much delayed. The progress at first is often rapid, the later stages are sure to lag behind; and the longer the thickening and infiltration of the tissues have lasted, the greater difficulty there is in getting rid of them.

Inflammation.—These changes are not due to inflammation. Pilcher, in describing the consequences of sprains affecting the wrist joint, has shown the difference between them with admirable clearness. It is perfectly true that the parts are swollen from the extravasation of blood, and the effusion of lymph; that the skin is sometimes reddened, and the temperature raised, owing to the increased amount of blood circulating in the vessels of the injured area; and that there is tenderness and pain, partly because the nerves are torn across, partly because the sensitiveness of the skin is heightened; but this, though it may end in it, does not make up inflammation.

The increase in the flow of blood is the natural outcome of the injury. A certain amount of repair is always being carried on, in correspondence with the ordinary wear and tear of everyday life. At times, from accidents or other causes, this work undergoes an immense increase; then, in accordance with the physiological laws which control all parts of the body, a much larger amount of blood flows through the part, and a greater quantity of reparative lymph is poured into it.

So long as the skin remains unbroken, it is altogether unusual for injured parts to become inflamed. Except under such circumstances as blood-poisoning (when any injury leads to abscess), or where from some accidental cause, such as the rupture of a large artery, a high degree of tension is set up in the tissues, inflammation following a subcutaneous injury is the exception, not the rule. Fractured bones, when the skin is unbroken, hardly ever excite inflammation; contusions and bruises may more often, because it is more common in them to meet with tension from fluid that is allowed to accumulate; sprains form no exception. Inflammation may set in from maltreatment or neglect; from peculiar conditions of the blood (such as gout or rheumatism) in which inflammation of joints sometimes occurs without any injury at all; or if a large amount of blood is allowed to accumulate, just as it sometimes does after a bruise; but under ordinary conditions it is not a necessary consequence, and may nearly always be prevented.

This is of material importance in the question of treatment. As regards the time at which this should be commenced, most people are agreed; and the methods adopted for the earliest stage have (most of them) something to be said on their behalf; but when the second stage is reached, as Pilcher, Hood,

and many others have pointed out, the mistaken notion of inflammation being a necessary consequence, has given rise to a plan which is not only directly opposed to all that is rational, but which, as might be expected of anything of which such a statement can be made, is to be regarded as the immediate cause of many of the troubles of later times. Small blood-vessels are always torn across when such accidents happen; sometimes the number is considerable; a certain amount of extravasation necessarily follows; this must be absorbed, and the injured tissues repaired or replaced, before the part can be said to have recovered, but it is always effected by perfectly natural means. The amount of blood that circulates through the part, and the quantity of lymph that is poured into the tissues, are increased in proportion to the work that has to be done. The softening of the intercellular substance is to facilitate this. It is only when the process passes beyond what is needed for the purpose, and becomes continuous and progressive, that it deserves the name of inflammation.

It does not do, however, on this account to run to the other extreme, and declare that inflammation never occurs. If a large amount of blood escapes from the vessels into the tissues, or if from using the joint too freely or too soon after it has been hurt, the hyperæmia is not allowed to subside, it is almost certain to do so. Anything that causes a high degree of tension is sufficient to induce it; the part begins to throb; the temperature rises; the swelling increases more and more until it may declare itself at any moment. It is more likely to break out in certain constitutions, and in certain joints; but if any synovial sac, or bursal space, is allowed to become distended, it follows as naturally as it does elsewhere. Only, so long as the amount of effusion is confined within due limits, so that the tissues can deal with it with a little assistance, without being overtaxed, inflammation is the exception, always provided there is no constitutional predisposition to bring it on.

Absorption.—These are the changes that take place in one direction. Side by side with them, commencing more slowly, it is true, but steadily progressing until it gains upon, and finally overtakes them, is the process of absorption. The sooner it begins, and the greater the activity with which it is carried on, the better the prospect of speedy recovery. When

it is incomplete, the consequences are always serious. As already mentioned, inflammation may set in and end in grave disease; the synovial cavity of the joint may continue distended with fluid until the capsule loses its elasticity and cannot contract again; the ligaments may be stretched and softened; there may be hard, unyielding masses of old blood clot lying among the tissues, and causing pain by pressing upon the nerves; or bands of lymph, converted into fibrous tissue, may pass from one bone to the other across the joint, making it stiff and rigid, and preventing free movement. Sometimes (after a sprained ankle, for instance) the soft tissues behind the bony prominences remain swollen and puffy for years, getting better from time to time, and then, again, especially of an evening or after any exertion, swelling up more than ever. At others, the nutrition of the part does not recover, and it remains cold and stiff, with a look of utter helplessness about it. Whenever, in short, recovery after a sprain is incomplete, and no actual displacement or other gross lesion can be found to account for it, the real fault is that absorption has never been thoroughly carried out, and that the circulation is not restored. The perfect recovery after these injuries is, however, of so much importance, and is so intimately bound up with the question of treatment, that it must be dealt with by itself.

The track of the extravasated blood, as it is absorbed, is easily made out. The red blood corpuscles break down, and are destroyed; their coloring matter dissolves in the fluid, and soaks into the tissues along the easiest routes, marking its path by the staining of the skin. The distance this spreads, and the length of time it lasts, may give some idea of the slowness with which absorption is carried on, even when the area is extensive. It is no uncommon thing for the bruising of a sprained ankle to reach the knee; and it may be many weeks before the last trace has vanished. Even then it disappears from the connective tissue interspaces outside the joint more rapidly than it does from the synovial sac within, or the bursæ and tendon sheaths round. In the one case it is widely diffused among the fibres, lying actually in the little interstitial spaces, out of which the absorbent vessels spring; in the other it occupies a cavity, only part of the wall of which possesses any absorbing power, and that not in a very high degree. Sometimes, owing to this, a few days after a sprain,

the joint appears larger in proportion to the parts round than it did shortly after the injury.

Gradually the semi-fluid material between the cells and fibres diminishes in amount, and becomes firmer in consistence; the surplus lymph, not needed for the repair of the tissues, is carried off, taking with it the remaining *débris* of the red blood corpuscles; and the nutritive plasma circulates again in normal amount, and at its normal rate, through the tissues.

Effects of Pressure.—It is worth noting how immensely these changes are assisted by the judicious use of compression. The extravasated blood betrays its presence everywhere by the stains upon the skin. In nearly every case it follows definite directions, being guided along certain strata either by the arrangement of the stronger sheets of fibrous tissue which surround and separate groups of muscles, or else by pressure applied from the outside. Where the bones lie immediately under the surface, so that the skin and subcutaneous tissues are firmly compressed when a bandage is applied, the color remains white and unstained. In the hollows between the bones, or behind eminences, which protect the soft parts, the tissues are swollen and puffed out, and may be jet black for a time. So it is with the effusion of lymph at a later period; only owing to there being here no alteration of color, the signs are not so conspicuous. The swelling always disappears first from those parts on which the pressure falls; it persists longest in just those places where it effects most mischief, in the little irregular hollows that lie between the bones, especially, as has been mentioned already, in the case of the shoulder, on the side where the tissues are softest and most yielding.

As the tissues shrink to their former size, the lining membrane of the joint cavity slowly resumes its natural appearance. Granulations cease to form on the inner surface; the latest formed cells, instead of dropping off into the fluid, become firmer and flatter, and are held together better by the cementing substance, so that they reproduce the glistening surface of the synovial lining. The fluid becomes more clear again, and its normal color and consistence return, though the quantity may continue excessive for a very considerable time.

Permanent Changes.—The fringes, and the tissues at their base, retain their altered character the longest. Often, indeed, they never quite regain their former size or texture. They

become firm and hard, and more opaque from the organization of lymph in their substance. Sometimes the larger ones become vascular, a loop of blood-vessels growing down into them from the base; and then they are practically permanent. If a joint has been sprained more than once, their presence can nearly always be detected in certain favorite localities, as, for example, on either side of the knee-cap. Owing to the synovial membrane being so superficial here they can be felt quite distinctly, even when they are still small, rolling between the finger and the bone. So long as they remain small they scarcely give rise to a sensation of inconvenience, but when they reach any size they act to all intents and purposes as so many fixed foreign bodies. Owing to their position, well out of the way of the bones, they do not often get caught between them, or they would prove a grave source of danger; but even though they escape this, they keep up a continuous if slight amount of irritation; the hyperæmia and effusion never quite disappear; the capsule and the ligaments become involved more and more, and the strength and security of the joint at length are seriously impaired.

Length of Time.—Where ligaments have been torn, whether they are completely separated in two, or, what is more usual, have merely sustained a number of small lacerations in their substance, it is, of course, a matter of some considerable time before perfect repair can be effected. So it is when muscles or tendons are torn, or if the sheath in which they lie is widely rent; and above all, if, before the parts are firmly united another undue strain falls on them. When this occurs, not only is the whole of the original mischief reproduced, but the degree is, generally speaking, more severe; for, owing to the vascularity and softness of the part at the time, the hæmorrhage and laceration are nearly always more extensive than they were at first.

It is impossible to lay down any precise rule as to the length of time required for the repair of these more serious hurts. Each case must be judged on its own merits. The amount of injury, not merely that sustained at the moment, but the subsequent damage often inflicted in ill-advised attempts at treatment; the kind of tissue that has suffered most; the extent of the extravasation; the particular kind of joint, whether in the upper or the lower limb; the age, and above all, the constitu-

tion of the patient; the care he will take of himself; all these things have to be considered with many others before an estimate can be given. All that can be said is that a severe sprain, tearing a strong ligament, or wrenching it from the bone, takes quite as long before union is perfect as a fracture through the bone near it. The patient may be able, probably will be able, to make limited use of the limb much earlier, especially if he is careful to avoid any movement calculated to throw a strain on the injured part (which, of course, in the case of a fracture is rarely possible); but recovery takes at least as long, and perfect convalescence, with perfect movement, often much longer.

CHAPTER VI.

IMPERFECT RECOVERY.

ONE of the most annoying things in connection with sprains is the frequency with which they improve up to a certain point and then come to an abrupt standstill. It is not merely that convalescence is protracted, it is delayed so long that it becomes a question if the joint is ever to recover. For the first few days, perhaps, everything progresses as well as it possibly can. The patient is wise enough to recognize the situation, and to reconcile himself to the necessary confinement, though this, as only those who have suffered themselves know, is very often far from being an easy matter. The dread of inflammation passes off, the swelling begins to diminish, the color of the skin changes from black and purple to green and yellow, the tender points can be touched again, and a certain range of movement is permitted once more, though in a tentative and cautious manner. With moderate good fortune this continues, until at the end of two or three weeks the injury is repaired, and the joint as sound and as trustworthy as it was before. Very often, however, it happens, as time goes on, that the improvement becomes more and more slow, until, perhaps, it comes to an end altogether, and the joint is left stiff, painful, it may be, and almost useless. The tissues seem to have been repaired, but freedom of movement does not return.

The extent to which this suffers differs very considerably. As has been mentioned already, the joint may be merely a little weak and unsteady, not quite to be relied on, perhaps, when called upon for any special effort; or it may be so stiff and rigid as to give rise to the suspicion that the bones are grown together, and the cavity completely obliterated. It may be perfectly free from all uneasiness in ordinary circumstances, or it may be the seat of constant aching, with frequent sharp twinges of rheumatic pain. In many cases it may be moved without inconvenience up to a certain point, but the

least attempt to carry it beyond this is stopped at once by pain, and a sense of resistance. Yet, in spite of this, the skin may be quite cool, and the tissues of the joint, to all appearance, perfectly sound. Sometimes, in cases such as these, it is possible to find a definite reason; a tendon may be displaced and have been overlooked, or one of the internal portions thrown out of gear; secondary changes, such as wasting or spasmodic rigidity, may have made their appearance in the muscles; or the capsule may be so relaxed that it is unable to maintain the necessary degree of pressure on its contents; but such as these, for this reason, must be dealt with by themselves. Those to which I wish to refer at present are altogether different; no definite lesion is to be found in them; they do not seem to have been severely injured; there is no evidence that the amount of laceration was extensive; yet they remain so stiff and painful as to be almost useless, without any apparent cause.

The severity of the sprain has nothing to do with it. It is quite as common after slight injuries as after severe ones. Indeed, it very rarely follows complete dislocations, in which the laceration is most extensive of all. It may even come on without injury if the joint has been inflamed; no matter how slight the attack, it sometimes leaves behind it a degree of stiffness that lasts for years, long after all trace of the exciting cause has passed, and without there being any gross change to explain it.

General Appearance.—There are certain features about these joints by which they may usually be recognized. If it is a superficial one, like the knee, the skin is reddened, but not with the bright flush of inflammation, or the ruddy glow of use; it is dusky and bluish, and if the finger is pressed upon it so as to drive the color out it is very slow in returning. Often it is cold to the touch; the patient may declare that it feels warmer than the rest of the limb, and even complain of a constant burning pain, but as tested with the hand, or, better still, with a surface thermometer, it is decidedly cooler. Sometimes the skin is smooth and gloosy, sometimes wrinkled, but it does not fall into the natural folds of the part, or glide evenly over the bony prominences beneath. It seems too tight, as if it were shrunken, and it cannot be pinched up, or made to glide from side to side Frequently one or two spots are exquisitely

tender, not merely when firmly pressed upon, but even if a finger touches the

The tissues round are wasted; the shape of the bones stands out too distinctly; the hollows are not filled in by muscles or by fat as they are in normal health. Even in joints so well covered as the hip and shoulder something of this can generally be made out by the eye, though measurements may fail. Occasionally, however, this is concealed by the swelling of the subcutaneous tissue round, especially in the case of the ankle joint, if the leg has been allowed to hang down for any time before it is examined.

Impairment of Mobility.—The most prominent feature, however, in connection with these joints is the interference with their movement. The limb in most may be bent more easily than it can be straightened; but it is seldom that it can be moved to its full extent in either direction. It is stopped abruptly as soon as a particular angle is reached; the check is so sudden and so firm that the bones seem locked together, and any attempt to force it further only causes intense pain shooting through the joint, often most severe where the skin is so tender to the touch. Generally, though there is a sense of discomfort and apprehension the joint can be moved up to this point without much distress, but occasionally even this is not possible. The pain is so severe, and the dread so great, that before the part is touched the muscles contract and hold it rigid, almost in spite of the patients' will. It is literally beyond their power to allow the movement to take place; the pain is to them so intense that their will is overcome and control over their actions lost

Muscular Rigidity.—In these cases it is impossible to form an opinion without anæsthetics. When the muscles are relaxed so that their action is eliminated from the question altogether, and there is no longer any fear of causing pain, the part may be examined thoroughly, and it is easy to ascertain whether the check is entirely the result of muscular rigidity or whether there is some other obstacle in addition. Such cases are not uncommon. Brodhurst mentions one in which the joint was so stiff and motionless as to give rise to the suspicion that the bones had actually grown together; when the patient was under an anæsthetic, movement was almost as free as it is naturally.

It is true that a good deal of information may be gained, especially in children, by diverting the patient's attention from the part, and carefully manipulating it at the same time. When this can be done, it is often discovered that the actual range of movement is a great deal wider than it appeared to be; but, in the first place, this is not always possible; and then, though the information is undoubtedly of very great service, it is never quite enough. It shows beyond question that the rigidity is due in some degree to muscular contraction; but it entirely fails to show how much. It is only possible to make certain of this when the muscles are in some way completely relaxed, so that they no longer enter into the question.

Creaking.—Creaking or grating, as the surfaces move on each other, is always present in these joints. It may be but the faintest sensation of friction, only to be perceived by pressing the hand firmly on the part, as if two smooth silken surfaces were being rubbed together; or the noise produced as the fluid is squeezed from one side of the joint to the other may be distinctly audible to those around. This, of course, depends on the condition of the lining membrane of the cavity, whether it has merely lost the polish from its surface or is covered over with folds and fringes, which project from all round the margin into the interior.

Bands and Adhesions.—It is a matter of popular belief that there is in these joints a band of some kind, passing across the cavity from one side to the other, independently of the lining membrane. When at rest this is quite loose; as the limb moves it suddenly becomes tense, and stops it abruptly, causing very severe pain by the way in which it is stretched. It is possible, of course, that a structure of this kind is developed sometimes; but I have never found such a one myself in a joint, nor am I aware of any case in which such a phenomenon has been recorded. Its presence would undoubtedly furnish a very simple explanation of symptoms that are often obscure; but it possesses the objection of being almost too simple. It explains all the facts at once, in such a plain and straightforward manner, that in the absence of all corroborative proof, one cannot but feel a certain degree of scepticism and reluctance in accepting it.

At the same time it cannot be denied that the evidence on which this opinion is based is very striking, and is sadly in

want of an explanation. A joint has been sprained some long time before, and for years has remained painful, and, comparatively speaking, useless; it has been rested, and bandaged, and blistered over and over again without the least benefit; any attempt to move it is stopped at once by the pain; every time it is tried it becomes swollen, hot, and tender; and apparently drifts down into a worse condition than it was before. All of a sudden, something gives way, perhaps with an audible snap; there is a moment's intense pain; but movement is regained, and recovery is perfect from that instant, without after trouble or ill consquence of any kind.

A good many cases such as this have been recorded from time to time, among others by medical men, from their own personal experience. Sometimes they have been cured by a designed plan of manipulation, sometimes by an accidental fall. There is, however, a certain amount of suspicion that they are not quite so common as is generally believed, for it is in the nature of people to spread abroad as widely as they can everything that savors of the marvellous. I have myself met with very few that could be called in any way typical, though, of course, instances of joint disease, in which great improvement has resulted from vigorous passive motion, are common enough. One instance was very characteristic. The patient was a strong, healthy man on active service, who had been invalided home owing to the condition of his knee. (I may remark that a very large proportion of the more striking cases occur in connection with this joint.) He had sprained it severely some months before in a fall from his horse, and as it was considerable time before anything could be done for him the swelling became enormous. Then it was kept absolutely quiet in a straight position for three weeks. Cold was applied, but not compression. At the end of that time the joint was exceedingly stiff and painful, but still he managed to get about upon it, and it improved gradually, up to a certain point. It could be straightened out fairly well, but could only be bent through about twenty degrees; as soon as this angle was reached it came to a dead stop, and any attempt to carry it further only caused the most intense pain and made the swelling worse. At the time that I saw him he was so disabled that he was only able to go upstairs with difficulty. The joint was very slightly swollen; so far as could be detected nothing

was out of place. All that could be found was a very tender spot on the inner side of the knee-cap, where the pain was always most intense. Circumstances at the time rendered it unadvisable that an anæsthetic should be administered, and a few days after he was completely cured by an accident. Coming downstairs he tripped suddenly, throwing involuntarily the whole of his weight on the affected limb, felt something snap, and fainted away from the pain. When he recovered the joint was a little tender over the old spot, but it could be moved as freely as the other. There was no increase in the amount of the swelling, and the pain was gone, nor did it return. (Strange cures of this description are not limited to sprains, as the following extract shows:—"Persons given to meditation must often have found ample material for speculation in endeavoring to imagine what train of thought could have prompted the introduction of certain surgical procedures, or led to the first trial of this or that therapeutical agent in the treatment of a particular disease. What, for example, could have stimulated the first idea of curing sciatica by stretching the sciatic nerve; certainly the task of finding a train of thought which should conduct to that conclusion would be a severe one. Many such methods have doubtless been suggested by a real or fancied analogy between them and certain natural accidental occurrences, and in this sort of observation charlatans in all ages have shown themselves singularly apt. We may quote a couple of instances of recent occurrence, where the cure was effected under circumstances which must have suggested to bone-shakers their violent and unscientific, but occasionally successful manipulations. In one case the person had been almost bedridden for many weeks from sciatica; still suffering acutely from the attack, but a trifle less in pain, he hobbled forth to get the benefit of a little fresh air; at a crossing he was roughly pushed by a passing vehicle, and after a desperate but unavailing effort to preserve his equilibrium he fell on the road in the midst of a fairly dense traffic. It was only when he had regained the sidewalk that he began to feel astonishment at the, in him, remarkable agility shown in jumping up and running to a place of safety. The sciatica had quite disappeared, and had not returned four years later. In case number two a strain had been followed by severe pain on movement over the outer condyle of the right elbow, which

lasted for several months, almost incapacitating the sufferer from pursuing his occupation as a hairdresser. There was no obvious lesion, but no treatment was attended with any benefit. One night, on leaving work, he had to find his way along a dark passage, in which the cellar door had inadvertently been left open. Against this he struck himself violently on the painful spot, giving rise to such pain that he nearly fainted. Within a day or two, however, as the effects of the bruise disappeared, the other pain was now noticed to be absent. The facts are rather curious, although it must be confessed it is not easy to see how to formulate any practical rules of treatment as a deduction therefrom.")

It certainly seems possible that in this case a band was developed in connection with the joint during the long period of repose, but I am not prepared to assert that it was in the interior of the sac. The tissues were very much swollen for a long time after the accident; the joint was never moved; a great deal of effusion was thrown out; the soft folds that exist round the knee-cap were immensely thickened, so that it is possible they gradually formed a connection along the interior of the capsule with those of the opposite side; as organization proceeded the union gradually increased in strength, until it was firm enough to check the movement of the joint: straining on it caused severe pain by the way it dragged upon the softer tissues; the sudden violent jerk tore it in two, and restored free movement. But it must be admitted that this does not rest on any direct or certain evidence.

Changes in the Tissues.—Opportunities for examining the interior of these joints must, from the very nature of things, be quite exceptional; and the difficulty of explaining the symptoms is not diminished by the fact that when one does occur the result is not always unequivocal. In a large proportion there is nothing to be found post-mortem; the structures appear as sound and as healthy as could be wished; and even where there is something definitely wrong, it is often so slight that it is impossible to believe symptoms of such intensity could be due to it alone. Clearly, the conditions upon which they depend must, in the majority of cases, be such that they come to an end, and disappear with the life of the part. Nor is it difficult to imagine of what sort and kind they must be. Changes in the circulation or nutrition of the tissues, for ex-

ample, often leave no trace behind, and yet may cause the most serious interference with the way in which the work is carried out. It is quite enough if the part is imperfectly supplied with blood so that the muscles are overloaded with waste products, and the nerves enfeebled and unable to play their part with sufficient energy. There need be no actual change apparent to our present methods of investigation; the tissues may be merely stiffened from disuse and badly nourished, unable to move freely, or accommodate themselves to each other; there is no need of more, it is quite sufficient, without having to invoke the aid of conspicuous alterations in structure.

The Interior of the Joint.—Sometimes there is an excess of fluid in the interior; more often, especially if the joint has been kept at rest for long, the quantity is diminished, and it is nearly always thin and serous in character, a little turbid, and not so oily as it should be. The cartilages are never much affected, the part they play is too passive, only in old and long-standing cases they lose the glistening polish from their surface, and are a little thinned. The capsule, with the loose tissue round, as a rule, shows more; instead of being soft and flexible, so that it falls into folds as the joint moves in one direction, and opens out again as it moves in the other, it is stiff and unyielding. In other cases it is irregularly thickened, with its inner surface marked by folds and ridges, in which are little elevations of the lining membrane; or at the point where it is attached to the bone, and the fibres diverge somewhat from each other, there is an accumulation of lymph holding them together, and as it becomes organized making one part drag unfairly and unevenly on the rest; or, again, there is an old extravasation of blood, the remains of some larger quantity, of which part has never been reabsorbed.

Old Extravasations in the Wall.—In one case, at least, I think I could attribute the whole of the symptoms to a cause of this kind. The patient was a man of more than middle age, who came to me complaining of an exceedingly painful and tender spot over the inner side of the knee joint, about half an inch from the margin of the knee-cap. There was a history of his having struck the joint against a sharp piece of furniture on this particular spot some weeks before. The skin itself was freely movable, but appeared slightly raised and puffy; there was no dislocation at the time that I saw him, and it

was doubtful if there had been any—at least, the patient had not noticed it. The pain on touching it was intense; steady pressure could hardly be borne at first, but seemed to relieve it afterward; walking, particularly going upstairs, and setting the extensor muscle of the leg in action, were both very painful. With the joint itself there seemed to be nothing wrong; there was no appreciable excess of fluid, and the tender spot was so fixed, that, almost certainly, it had nothing to do with the formation of any fringes or foreign bodies in the interior. The suggestion was that either some of the fibres of the muscle inserted into the capsule had given way, or that there had been a small hæmorrhage into the substance of the capsule itself. I had the opportunity of examining the joint at a later period, and was able to verify the diagnosis; so far as I could ascertain the muscular fibres were intact; in the substance of the synovial membrane, corresponding to the painful spot, there was a small hard mass projecting further into the cavity than it did on the exterior, probably because there was least resistance in this direction. It seemed to be the residue of an old extravasation; the blood had been effused between the fibres of the capsule; some of it had been absorbed; the rest, owing to the protection it received from the side of the knee-cap, escaping all pressure, had become organized and formed a small hard nodule. Probably this happens in many cases without material consequence; most likely in this particular one it implicated in some way or other a nerve filament, and, like the little peculiar tumors known as painful subcutaneous tubercles, when it was touched it dragged or pressed on the nerve and gave rise to stabs of acute pain.

Dry Synovitis.—Barwell has described under the name of dry synovitis, another condition which may exist in some of these cases, and help, in a measure, to account for the symptoms. There is, according to him, a deposit of fibrinous material on the inner surface of certain parts of the lining membrane, probably derived from the fluid which collects in the joint when it is inflamed. During life these spots are so painful that the patient will hardly allow them to be touched, and can scarcely be persuaded to move the limb. Sometimes the pain is paroxysmal, and often periodic in character, and it is always severe to a degree which bears no comparison with that of ordinary synovitis.

Neuralgia.—Occasionally the pain and loss of power are caused by a kind of neuralgia, which attacks joints and seriously interferes with their freedom of action, without leaving behind any visible evidence of its existence. These may be recognized by the peculiar periodic character of the pain, and by the way in which it is limited to certain spots, which correspond fairly well to the places where the nerves penetrate the fibrous capsule. The skin immediately over them is exquisitely tender to the touch, and sometimes puffy, or slightly swollen; and movement is limited, because, as the joint bends, the capsule is exposed to different degrees of tension, and in certain positions the affected nerve is pressed upon or stretched. The check, however, in these is rarely so abrupt as it is in the others. In one case under my care it appeared to alternate with supraorbital neuralgia, the pain sometimes occurring in one locality, sometimes in the other, but scarcely ever being present in both at the same time. The patient, who was thoroughly overworked, was readily cured by rest and change of scene.

Tissue Starvation.—In a large number, however, this explanation fails as well. There is no evidence of neuralgia; there is no gross lesion to be detected anywhere; no increased effusion, thickening, or adhesion; the tissues simply are wasted; the muscles have lost their power, and the joint is so stiff and painful that it is almost useless. The real reason is the prolonged want of use. The tissues are starved and badly nourished. During life they are surrounded and bathed in a nutritive fluid, which pours out through the walls of the vessels and permeates them in all directions. It spreads everywhere in the interstices, giving up to the structures with which it comes in contact the material they require for their growth and action, and taking away whatever is worn out. The surplus is drained off by a special system of vessels, the absorbents, so that it may never remain stagnant. The rapidity of its flow is entirely regulated by the activity of the tissues. If they are in constant use, a larger amount of blood comes to them; more of this plasma passes through the walls of the vessels into the spaces round; the supply of nutritive material is greater, and the waste more rapidly carried off. If, on the other hand, the part is kept in a condition of absolute repose, the plasma lies stagnant round and between the tissue ele-

ments, so that when they are suddenly called upon for active work they are unfitted and unable. Until the free current of the plasma is thoroughly re-established once more, recovery of power is impossible. When this is effected the parts regain their strength and vigor almost of themselves.

Even a healthy joint that is kept absolutely at rest may be so badly nourished that it becomes stiff and unfitted for work, especially if the demand is urgent or severe. If it has been injured or inflamed, so that there is a larger amount of waste and greater need for repair, and is then kept motionless, this result is almost certain to occur.

It is a common thing to call such joints as these hysterical, merely because there is no evidence of any gross or conspicuous lesion; nothing, for example, is out of place, and no band or adhesion can be detected. But it is more than doubtful how far this is correct. When a joint becomes stiff, and the muscles wasted because they have been disused and are not properly nourished, it ceases to be purely and simply hysterical. It is true this may have been the starting-point, because of this the joint may have been kept at rest or prevented from enjoying its full range and freedom of action; but when changes of this description have once made their appearance there is something above and beyond mere hysteria. There is a local affection which can only be cured by local measures, and which must be cured before the hysterical condition can disappear. So long as it persists the patient is convinced, and quite rightly convinced, that the joint cannot be used freely as it ought to be. It is quite true that it cannot, and until it has regained its freedom of action, and the muscles their strength, it is hopeless trying to convince the patient that it can. Happily in many instances the changes are so slight that the joint recovers if it is only used in a moderate degree; if, for example, under the influence of change of air, or change of interest, the patient's attention can be diverted from it. Often, however, this is not enough, and then measures must be taken, first to give back to the joint its complete range of movement, and then to restore the nutrition of its tissues so that they may regain their power and activity.

CHAPTER VII.

TREATMENT. COLD. HEAT. PRESSURE.

It must be admitted there is something very unsatisfactory in the results obtained by the ordinary methods of treatment. Even when the greatest care is taken, when every precaution is used, tedious convalescence is the rule, rapid and perfect recovery the exception, and often, owing to carelessness or delay, the joint never recovers at all. It is left weak or tender, not so trustworthy as it was; prone to swelling with the least exertion, and sensible to every change of weather, so that there is an end once and for all to the healthy unconsciousness that such a thing as a joint exists.

The reason is not far to seek. In a large proportion of cases the measures adopted are altogether insufficient; in some they are absolutely wrong, when, for example, a joint is kept perfectly quiet until it becomes hopelessly stiff; while in nearly all the time that is of the greatest value, that which immediately follows the accident, is allowed to pass by without anything being done, and completely wasted.

Whatever plan is adopted it is essential to begin at once. Every moment lost makes a serious difference. The injury is not confined to the instant of the accident. The blood keeps pouring out from the wounded vessels and accumulates in the synovial sac and the interstices of the tissues, until if left to itself it causes such an amount of pain and tension that inflammation is bound to follow. If recovery is to be speedy or sound this must be stopped at once, or, at any rate, confined within the narrowest limits. When once it has left the vessels, and become extravasated, it serves no useful purpose, whether it collects in the cavity of a joint or spreads itself through the loose tissues of the limb. It separates the ends of the torn ligaments; it distends the synovial sac until it becomes stretched out of all proportions, and when it is absorbed

it leaves the capsule loose and flaccid, so that the joint feels weak and powerless. If it remains, the consequences are worse still; either it breaks down and forms an abscess, or, as already described, becomes organized into a hard unyielding mass, which interferes with the action of the muscles and compresses the nerves so that free use of the limb is rendered impossible.

The first thing to be done then is to check the bleeding into the tissues, and to spread out over as large an area as possible the fluid that has escaped already. Then, as reaction sets in, as the part becomes warm and red, and as the quantity of blood circulating through the uninjured vessels begins to increase, steps must be taken to keep this well within bounds. There must be a certain increase; it is essential for repair; the injury entails more work; there is a larger quantity of worn-out material to be removed and replaced, and more blood is required for it. Only it must be kept strictly within limits, and not allowed to run on until the synovial sac and tendon sheaths become distended or inflammation itself sets in.

If this can be done little further is required. All that remains is to assist the circulation through the tissues in every way, to maintain the nutrition at its highest level, and by gentle passive motion prevent the limb becoming stiff. Repair takes place with very different rapidity in different people and in different ages, but ligaments that have given way, or that have sustained many small injuries in their substance, naturally cannot in any circumstances be repaired at once.

Cold.—When the matter is thought out there is something almost ludicrous, if such serious consequences did not follow, in the general way in which, as a matter of routine, a wet bandage is applied to a sprained ankle. For the moment it is cool and pleasant, and with the folds and turns lying evenly and smoothly on each other, looks exceedingly neat. The uniform pressure does give relief at first, but in a very few minutes the coolness disappears and the temperature is as high as that of the joint beneath. In a few more it begins to dry, and as it dries it becomes loose, so that the pressure (which never at any time falls quite in the right part) disappears altogether. If the bandage is removed and the limb examined it is smooth and round, with the hollows quite filled up. The bandage, of course, passes over them without pressing upon them, reserving this for the bony prominences which

do not require it. The soft tissues are swollen and œdematous, and the synovial sac and the tendon sheaths distended with fluid. Applying it again in the same fashion does no good, nor is it of any use keeping the bandage wet. The principle is correct, but the method of application altogether a failure. Neither the cold nor the pressure is applied effectually, and the result of this method of treatment may be seen in the fullness and swelling that persist round ankles for years after they have been sprained.

The fault is not that of the cold. This is one of the most useful and satisfactory applications known. It may be dry or moist; it does not matter how it is obtained. The limb may be surrounded with ice or cold spring water poured over it, or it may be immersed in the water, or any other method adopted that suggests itself at the moment. The important point is that it should be applied at once, and that the limb should not be allowed to recover its temperature until a more permanent application is ready. Used in this way, as a first agent, cold is simply invaluable. It is always at hand, any one can apply it, and it fulfills every indication. The blood-vessels contract at once, the skin becomes white, the bleeding is checked, the sensitiveness to pain is diminished, and the tendency to swelling very much lessened.

If, however, it is used in a hap-hazard sort of way, as it is under a wet bandage, if the limb is allowed to grow warm from time to time, the whole of the benefit is lost. Reaction follows as the effect passes off; the blood-vessels dilate again until their diameter is much larger than it was before. More blood flows through the skin and the adjacent parts; a larger quantity pours out where the vessels are torn; the temperature rises; the sensitiveness of the skin is increased; it begins to glow, and the patient becomes conscious that the joint is increasing in size. In reality more harm is done in this way than if the the part is left entirely to itself. In some people who are more than usually susceptible, it is enough to produce results of exactly the opposite character to those intended, and in the later stages of sprains, when the joint is cold and powerless, it is used in this way for this very purpose. The alternate action of cold and warmth is one of the most effectual measures known for stimulating the circulation through a part, and if employed soon after the infliction of such an injury as

a sprain, before the ends of the vessels have had time to close, certainly does more harm than good.

As a Temporary Application.—It is equally important that the application should not be continued too long. As an immediate and temporary expedient cold can scarcely be surpassed, but after a time a condition of passive congestion sets in. The nerves and the delicate muscular fibres on which the contraction of the vessels depends become paralyzed; the part becomes red and swollen, in great measure from the blood that lies stagnant in it; the skin is anæmic, shrunken, and rough from the upstanding papillæ; the amount of blood and lymph in the tissues is sufficient, but it is never changed; the vitality of the part is lowered; the nutritive changes on which repair depends are carried on more feebly, and if the process is continued may stop altogether, so that the part either actually perishes or is attacked by a low form of inflammation. Even when the effect falls far short of this, long-continued cold brings about a state of things in the tissues that is by no means favorable to the repair of injury.

Method of Application.—Cold may be applied in a multitude of ways, but as a rule the simpler the method the better. It may be dry or moist. In the former case it acts by conduction only; in the latter by evaporation as well, but it is possible this advantage is more apparent than real. It is much more important that time should not be lost, and that the injured limb, especially if it is the ankle, should not be allowed to hang down, as it nearly always is. In some parts of the body, such as the hip, there is no doubt of the superior comfort of the dry method; in others the position in which the limb must be placed, and the facility with which the cold can be applied, form the best guide.

Cold spring water is nearly always at hand. It may be either poured freely over the injured part, or this may be immersed in it. The former plan is the more efficacious; independently of the fact that fresh quantities of water are continually being brought into contact with the skin and abstracting heat from it, and that a certain amount of evaporation can take place as well, it is probable that the actual impact of the falling water, perhaps by the shock and the influence it has on the nerves in making the vessels contract, perhaps by the force of its fall, is of great assistance. As soon as the joint

ceases to swell and the skin is beginning to look dull and livid, the maximum amount of benefit has been produced. It is rarely advisable (at any rate, if pressure can be applied) to carry it any further.

The same effect may be produced by immersion, but unless the water is very cold it is much more slow, probably because the layer next to the skin is soon warmed to the temperature of the body. If ice can be obtained at once in sufficient quantity, the result is as rapid, but there is the disadvantage that it is nearly always necessary to allow the limb to hang down, a position which should always be avoided, as it tends to increase the amount of blood in the part, and sometimes makes it much more painful.

Continuous Application.—A few days after the accident, if by any mischance inflammation does set in, cold may be applied continuously, but then the reason is not the same. In these circumstances it may be kept up for an indefinite length of time. The object is to diminish the amount of blood circulating through the part, and so to lower the temperature and reduce the inflammation. But in sprains, ordinarily speaking, there is not any inflammation to reduce. As Hood and many others have pointed out, there is absolutely no reason why, when a sprain occurs in a healthy person, and is treated with a reasonable amount of care, this complication should set in more often than it does in the case of simple fracture.

The most convenient fashion for its continuous application is by a set of Leiter's coils. They may readily be improvised out of India-rubber tubing (the best is that which has an internal diameter of about one-third of an inch and moderately thin walls), or better still from composition gas-piping, which has the advantage of retaining the shape to which it is bent. They may be applied to any part of the body, coiled round a limb, for example, without the circles being in any way fastened together, or wound in a flat spiral and rested on the part, as in the groin, or pressed into the shape of a low cone and arranged to fit the shoulder. All that is necessary is that there should be two buckets, one containing water of the desired temperature placed on a stool a little higher than the limb, and connected with one end of the coil by means of a piece of tubing; the other, on a lower level, empty, and connected with the other end. As soon as the current is started from one to the

other the flow is continuous, and may be regulated with the greatest accuracy. It is not essential that the cold should be confined strictly to the part actually inflamed. If an ice-bag is laid on a limb over the course of one of the main arteries it causes a very sensible diminution in the temperature of the part below by the constriction it induces, and by the proportionate diminution in the amount of blood.

There are other methods as efficacious, but less convenient. One depends on the well-known fact that if a skein of wool is allowed to hang over the edge of a vessel, so that one end dips in the fluid inside and the other hangs over the edge, a continuous stream of drops will come from the dependent half until all the fluid is gone. A drip pot of this kind, or more than one, suspended over a limb and filled with evaporating lotion reduces the temperature quite far enough. Iced water, or a lotion containing chloride of ammonium in solution, answers very well, but if the full effect is desired there is nothing to equal lead lotion mixed with spirit, and containing a few fragments of ice. The effect is greater in proportion to the amount and strength of the spirit. It may be allowed to drip on to the skin directly, or this may be covered with a single thickness of lint, so as to avoid splashing, and to carry off the surplus fluid. If the lint is folded even once, so that there are two layers, evaporation is checked to a considerable extent, and a great deal of the effect lost.

Arnica, which is frequently recommended in the early stages of sprains, is worse than useless. The sole merit that it possesses is due to the spirit that is mixed with it, and it has the very serious defect of exciting in many people (especially when it is not very much diluted) a peculiar form of inflammation of the skin, which is not only very difficult to distinguish from erysipelas, but which is very likely to run on into it. Aconite, too, may be mentioned here as occasionally of service when one or two small spots are exceedingly tender, but care must be taken, especially when it is mixed with chloroform, that it is not applied over too large a surface.

A still more simple way of applying cold is to fill an India-rubber bag (or where this is not handy an ordinary bladder answers all the purpose) with small fragments of ice, or with ice and salt, and to allow it to hang over the joint so as just to be in contact with it. A double fold of lint, or a thin

pocket-handkerchief, must be placed underneath, lying on the skin and changed occasionally, as it soon becomes wet from the condensation of moist air on the outside of the bag. This plan is particularly useful when it is desirable to produce an effect on deep-lying structures, or to keep the cold up for a considerable length of time, as it is very effectual, may be graduated exactly, does not want watching, and makes no mess.

Cold is most successful in sprains of large joints when the swelling comes on rapidly. If twelve or more hours pass by before this makes its appearance, pressure applied early answers a great deal better, though even then, if a joint such as the knee or ankle has been bandaged carefully, an ice-bag laid on it makes its influence felt, and helps to relieve the feeling of tension and throbbing. When the brunt of the injury is borne by the muscles it is not nearly so serviceable. In the aged, in the very young, in those subject to local congestions such as chilblains, and in the rheumatic, it must be used with great caution, and the skin, if it is moistened, must be dried with the greatest care; otherwise it may happen that the depression due to the cold insensibly shades off into an attack of inflammation, the very thing it is intended to prevent.

Heat.—Heat may be employed in many cases in which the use of cold does not seem advisable. Its value as an immediate application depends on the fact, which is not so widely known as it might be, that hot water, if the temperature is sufficiently high, is as effectual in stopping bleeding as ice. The skin becomes cold, the vessels in it and in the layer immediately beneath contract, and the circulation in many instances almost stops. In the case of the fingers, where in proportion to their thickness the extent of surface is very great, I have seen complete blanching and numbness produced by dipping the hand into very hot water, and have known it last even in the hot days of summer for many hours, longer than if it had been due to the application of ice.

To produce such an effect as this the temperature of the water must be as hot as can be borne. It cannot, therefore, be kept up for more than a few moments, for fear the skin may be injured; and for the same reason it cannot be employed, as cold is, to diminish the calibre of the vessels in the deeper lying structures. Its value is greatest when the in-

jured part lies near the surface, particularly in the case of tendons, which, like those on the back of the hand, run a long distance down into the fingers, lying immediately under the skin the whole way. In the ankle and elbow, also, it succeeds fairly well, but the difficulty of application in the case of other joints is so great that it is generally better to rely on cold.

The temperature of the water requires a good deal of judgment, especially as different people, even different parts of the body, vary very much in their degree of tolerance. With children, it is particularly necessary to be careful, as their skin is so delicate. Happily in them joint sprains are not so common as they are in adults. The fingers can stand a higher temperature than the hand, and this, again, a much higher one than the elbow; indeed, the point of the elbow is, so far as heat is concerned, one of the most sensitive parts of the body. The extent of surface immersed has to be considered, too. It must not be forgotten that the sensitiveness to heat increases with the area exposed. It is not a bad plan to place the limb in hot water, and then raise the temperature rapidly by adding more, until it is as high as the patient can stand, taking care to stir it round all the while, so as to distribute the heat evenly through the whole. Two or three minutes ought to be sufficient; often the full effect is gained at the end of the first.

Heat used in this way has a wonderful power of relieving pain. The skin may not be blanched, but its sensitiveness is lowered; manipulation is more easy, and displaced tendons or other structures can be restored to their position without the sickening sense of over-stretched fibrous tissue. It is worth noting, moreover, as another point in its favor, that the effects are more lasting than those of cold, and consequently time is gained for the application of other and more permanent measures, such as massage and bandaging.

Sometimes, after prolonged overwork or severe strains, the bony prominences to which the muscles are attached become sore and tender, or the tendon sheaths seem to be roughened and uneven, so that perfect smoothness of motion is lost; or in certain classes of work, where without the actual exertion being great, rapidity and delicacy of movement are carried to a very high pitch, the nerves become painful, and the muscles liable to sudden and spasmodic contractions. When this oc-

curs the prolonged application of warmth may generally be relied upon to give relief, at any rate for a time. A moderate temperature usually suffices. The object is not to numb the sensibility of the part, but rather to relax the walls of the vessels and relieve the tension, so that blood may circulate more freely through the tissues, and the delicate fibres, in which the nerves end, may no longer be kept upon the stretch. This holds good even when some of the muscular fibres have been torn across or rent from their attachments.

Later, when the joint is beginning to recover and movement is returning, heat is of value both for its own merits and as a preliminary to massage. There is then no limit to the length of time it may be applied. The hand, for example, if it is stiff from the effects of some old sprain, may be kept soaking for hours in water as hot as can be borne with the greatest benefit. The tissues become soft, everything is supple and flexible, the constant aching disappears, and movements which before were out of the question are executed with ease and freedom; only, unfortunately, it rarely happens that the whole of the improvement is retained. So far as stiffened joints, at least, are concerned, it does not seem improbable that the reputation enjoyed by many of the foreign baths is due more to the temperature of the water and the length of time the limbs are allowed to steep in it than to anything else, though it is not denied that in other respects they may be of considerable service.

Besides these there are other methods, less general in their application, which are better described in the treatment of special sprains. Ironing, for example, is often of great use where large masses of muscle in the loins are stiff and painful from overwork or cold, so that the patient cannot move with freedom or even hold himself erect; and hot vapor or mud baths, where the limbs are stiff and crippled from old attacks of inflammation, frequently procure great relief from pain; but remedies of this description must be dealt with by themselves. As a rule, they are used in conjunction with others, and do not depend for their merit on heat alone.

Heat and Cold Alternately.—Later still, when the repair of the tissues is perfect, but full use is not restored, nothing can be more successful than the alternate action of heat and cold. Some weeks, perhaps, have passed since the joint was

hurt; all fear of inflammation has been dispelled; there is nothing out of place; no bands or adhesions to hurt the movement; no very tender spot, though the whole may ache, especially after it has been used; but there is no power in it. The joint is colder than its fellow; the skin is livid and wrinkled, fitting closely on to the bones, and often slightly swollen where it stretches over the hollows between them; the position of the parts is natural and good; one bone can be moved upon the other, though, perhaps, not quite to its full extent; but the part looks and feels as if it were only half alive, able to put out half the energy it should. Sometimes, it is true, this is the result of defective energy and will in the great nerve centres, but often the fault lies in the part itself. The tissues round the joint have been at rest so long, have been so long without doing anything for themselves, that they have almost lost the power. The circulation through them has been at its lowest ebb for such a length of time, that when a sudden demand is made upon it it is unable to respond. In these circumstances the shock of alternate heat and cold acts as a most powerful stimulus, especially when used in the form of a douche, projected with some force and suddenness against a part which has been allowed to soak in hot water. The skin, of course, receives the greatest amount of effect, and sometimes, especially with the needle douche, a great deal more has been done than was desirable; but the whole circulation through the part is quickened; the volume of blood increases; the nutrition of the tissues is carried on more as it is in normal health, and the muscles and nerves begin at once to regain their power. Aided by galvanism and other measures, it is surprising how this method of treatment restores tone to the muscles, and causes the absorption of chronic exudations that perhaps have remained passive and unaltered for years; only, partly from the very ease with which it may be applied, it is not advisable that this line of treatment should be carried out without suitable supervision; or more harm than good may easily be done.

Pressure.—This is not the only plan which illustrates the value of a time-honored practice, when carried out thoroughly, and its worthlessness as usually employed. Bandaging for sprains is almost universal, and well deserves its reputation; only it must be carried out systematically and rationally, with

a proper regard to the structure of the joint, the arrangement of the parts round it, and the movements it ought to perform; and this implies anatomical and surgical knowledge of no mean order.

Heat and cold are only of temporary use; their influence on the vessels is exerted through the nerves and muscles, and after a time these, like other vital structures, become tired out, relax, and give way. Both of them when continued too long help to produce the very effect they are intended to prevent. The tissues become congested; the circulation is checked, though the actual amount of blood in the part may even be greater than normal; the cavity of the joint is distended; and the soft tissues round and between the bony prominences are filled with exudation, which becomes organized, develops into tough and unyielding fibrous bands, and cripples the movement of the joint in all directions.

As compared with these the action of pressure is entirely mechanical; the measure may be graduated according to the needs of each case, and it may be kept up at any required degree for an indefinite period of time. When carefully and methodically applied, nothing can be more efficient for stopping bleeding, or for insuring the absorption and dispersal of blood that has escaped already. It controls the hyperæmia and checks the dilatation of the vessels, so that the outpouring of the plasma into the tissues is restrained within proper limits. It prevents the accumulation of fluid in the synovial cavities; assists the absorption of plasma from protected spots, so that it neither runs on to inflammatory exudation on the one hand, nor becomes organized and leads to stiffening of the joint on the other; and above all it relieves pain in the most wonderful way, whether it is the sharp and acute kind that comes on immediately after an accident, due to the stretching and tearing of the nerves in the ligaments and fibrous structures, or the dull aching afterward caused by the continued tension on the capsule. In the majority of instances, if compression is properly applied, the swelling disappears by the next day, and the joint may be moved through nearly its whole range without more than a sense of discomfort.

Method.—To bring about this result, however, the compression must be applied with a definite knowledge of what is desired, and how it is to be obtained. Merely putting a band-

age on a limb that has been sprained is only liable to perpetuate the very evil it is intended to prevent.

It may be commenced at once, as soon after the accident as practicable, or heat or cold, as the case may indicate, may be applied for a short time first. Probably in most cases the latter plan is the better; heat or cold requires less skill, and relief from pain is attained more immediately, while, if carried out effectually, time is not really lost. Besides, before a bandage can be applied, it is necessary to make perfectly certain that there is no displacement of any kind. If there is anything of the sort it must be made out and rectified before further steps are taken; it is hopeless trying to cure a sprained joint if any of the structures belonging to it are out of their natural position. How far it may be advisable in these circumstances to make use of massage as a preliminary, is a question that is best dealt with by itself.

The method of application is all important, though the rules that guide it are sufficiently simple. The joint must be fixed in the most suitable position, not necessarily the one selected by the patient. For example, in sprains of the ankle the foot should be at right angles with the leg; when the knee is injured the joint should be slightly bent, though not nearly to the degree in which the patient is almost sure to place it, and the arm should hang by the side when the shoulder is involved.

The pressure must be applied so that it falls only on the parts that require it, not on the bony prominences, that is to say, but over the tendon sheaths, and on the masses of soft and delicate tissue that fill up the interspace between them and the bones, especially on the inner side of the limb. It must be smooth, even, and well graduated, commencing from below, and working upward toward the trunk, and it must possess a certain amount of elasticity, so that as the swelling diminishes under its influence the bandage may still keep up some degree of compression.

For this purpose there is nothing more suitable, and, fortunately, nothing more easily obtained, than ordinary cotton wool. Pads may be made of this to fit into any depression, no matter how small, and, if not too firmly compressed, they keep up an even and equable amount of pressure, even when absorption underneath has effected a considerable difference in the size of the limb. Failing this, the next most useful sub-

stance is a firm and fine-textured sponge. This may be made into pads which admit of the most perfect adjustment as regards size, shape, and thickness, and it is more easy to keep them in their proper place when the limb is being bandaged. Many other substances, however, serve on special occasions; dried moss, for instance, forms a capital substitute, and I have known even seaweed tried with success. Some of the thicker and softer kinds of felt make admirable pads, firm and soft, yet quite elastic, and capable, if several layers are sewn together, of being modeled into any shape. Sometimes this firmness is of especial service. I have employed them with great advantage in sprains of the extensor tendons on the back of the wrist, when the distention has not been very great, but where there has been a large amount of creaking or grating on movement. It is difficult here to adjust pads of cotton wool sufficiently accurately, while the felt is easily shaped to suit the varying thickness of the soft parts. The pressure is distributed evenly over the whole length; the tendons are kept at rest; and the firm compression insures the rapid disappearance of the exudation.

Pads of sponge or felt may, moreover, be soaked in lotions, if it is considered advisable, without altogether destroying their elasticity. I have not found much occasion to put this into practice, but once or twice, when the pain over small joints was very severe, the application of a lotion containing a solution of morphia afforded great relief. Of course, a certain amount of caution must be used. A thick felt pad, covered on the outer side with a layer of some waterproof material, is capable of taking up no inconsiderable quantity, but the area of the pad is generally small, and the condition of the parts beneath is not one adapted for rapid absorption. If there is the least abrasion this caution is particularly required.

It is impossible to be too careful in molding the pads to the proper shape of the limb. In the case of the ankle, for example, where the joint alone is involved, the swelling shows itself on the front, lifting up the tendons that run down to the toes, and behind on either side of the tendo-Achillis, filling up the natural hollows there, and reaching up the leg higher on the inner side than the outer. Over the malleoli, of course, there is none, and, unless the injury has been so severe as to tear the ligaments, scarcely any is perceptible along their

lower border. This may be complicated by the distention of some or all of the tendon sheaths that run down on either side; and if some few hours have been allowed to pass by, there is, in addition, a great deal of thickening in the loose and delicate tissue that fills up the interstices between the skin and the tendons, and the tendons and the bone. The swelling may reach down far on to the foot, and almost to the knee. All this must be made out; and the natural contour of the limb seen, as it were, through the swelling, before the pads can be shaped and the bandage adjusted.

Sometimes pads of this kind may be made to serve in the place of splints. In the knee, for example, a bandage, as usually applied, is of very little use; nor is it much better if a horseshoe-shaped cushion is adjusted around the knee-cap. But if this is combined with a firm elastic pad of felt in the popliteal space behind (I have known, when nothing else could be obtained at the moment, a small folded pocket-handkerchief answer admirably), the compression is spread over a larger surface of the joint, better resistance is given for the bandage in front, and an admirable splint is applied to the knee joint, keeping it nearly straight, and possessing the great advantage over an ordinary back splint that it is not so absolutely and uncomfortably rigid.

Sometimes it is one's misfortune to meet with a case in which the limb (generally the forearm) seems to have been sprained, as it were, all round, the swelling and pain are so universal. For such as these I have used with success what may be considered a distant imitation of Guérin's treatment of wounds; that, at least, first gave me the idea. The limb is to be well padded first, according to the anatomy of the part, and lightly bandaged; then, commencing from the fingers, between which small cushions are placed, it must be wrapped in sheet after sheet of cotton wool until it is three or four times the natural size; finally, it must be bandaged from below upward as firmly as possible. If the cotton wool is sufficiently thick it is impossible to exert too much pressure. It must be admitted that the application is exceedingly hot; but it certainly relieves pain; and such is the elastic tension of the wool, that the limb, when exposed on the next day, is almost its natural size. The comfort is greatly increased by dusting the limb over first with violet powder.

Bandages used for sprained joints need not be of any special kind so long as they lie evenly and smoothly on the limb and do not stretch. India-rubber ones, or those made of woven elastic, are strongly recommended by some; but, it seems to me, without adequate reason. They keep the limb very hot; the solid ones, at any rate, retain the perspiration so as to be sometimes unpleasant; and it is very difficult to apply them sufficiently firmly without making them too tight and converting them into a species of torture. While the limb is being bandaged the pads may be secured in position by means of common elastic bands passed round the limb, an excellent method suggested by Dacre Fox.

Starch bandages and other fixed appliances, such as gum and chalk, plaster of Paris, or silicate of potash, can only be recommended under special conditions. They are certain to be left on too long, and that is a fatal objection. Bandages, as a rule, should be changed every day. The limb no doubt feels fairly comfortable so long as it is encased and kept motionless. But every day it is growing more and more stiff, and when it is released the least attempt at movement is attended by pain. This is not due to straining or tearing of the union between the ends of the torn ligaments; no strain falls on it. Ligaments may be tense, but they are not stretched unless movement is carried beyond what is natural, which, under proper management, never should happen. It cannot, therefore, be due to this. In reality its persistence and severity are regulated more by the amount and duration of the swelling than by anything else. Of course if ligaments have been torn from bones, or muscles have been strained or lacerated, the skin over them is tender when it is pressed upon or tightly stretched, but the pain that is ordinarily felt when a sprained joint is first used is scarcely noticeable if exudation is prevented and passive motion begun early enough. Neither of these conditions is likely to be carried out properly if the limb is encased in a fixed bandage.

How long the limb should be bandaged is a question that can hardly be answered until the effects produced in joints by prolonged inaction have been taken into consideration.

CHAPTER VIII.

TREATMENT.—REST.

NOTHING is so difficult in the treatment of sprains as the question of rest— how long the joint should be kept quiet, and when the patient may use it with safety as he likes. It is the first thing asked, and a definite time is usually wanted at once, utterly regardless of the fact that it is impossible to return more than a general answer in the majority of instances. Each case must be judged on its own merits. On the one hand, if the joint remains long unused, there is the possibility, almost the certainty, of its becoming stiff and crippled, so that it is years before it regains its natural freedom, if it ever does; on the other, there is the dread of exciting inflammation, and the risk of reproducing by some momentary slip the whole of the original mischief. Between these it is necessary to hold a middle course; leaning too much to either side inevitably brings after it delayed convalescence in some form or other and much discredit.

There is no doubt that in the majority of cases sprained joints are kept at rest much too long. It is imagined that if anything, it does not matter what, has happened to a joint, it cannot be wrong to rest it, and that no harm can possibly follow from its being kept quiet. The dread of inflammation is allowed to overshadow everything else. It is forgotten that the function of a joint is movement; that this is the reason for its existence, and that if from any cause it is kept absolutely at rest it loses the power of working, just as an eye accustomed to long-continued darkness becomes unable to bear the light. It is forgotten that prolonged rest does produce changes, and very definite ones, too, in the structure of joints, even when they are healthy, and that these are tenfold more likely to occur after injury. And so the part is kept perfectly quiet until it becomes stiff and rigid, and every attempt at movement causes pain.

Effects of Prolonged Rest on Healthy Joints.—Some of the effects stated to result from this cause are of a very striking character. Duverney and Petit have described cases in which they found the synovial sac and the spaces round it enormously distended with a serous effusion; and others in which there were adhesions passing across the interior from one bone to the other, so that the joint was almost crippled. Teissier has given an account of one in which the adhesions were so dense and numerous that the cavity of the joint was entirely obliterated, and the bones so tied together that one could not move in the least upon the other. In others he found the synovial sac distended with blood, the lining membrane thickened, and more vascular than natural, and the inner surface coated over with a recent deposit of fibrinous material, which was rapidly being organized into dense unyielding bands. In many the cartilages were swollen and thickened at the margin, softened in the centre, and even eroded on the surface, while the synovial fringes were almost uniformly converted into tough fibrous bands that limited the fredom of the joint in all directions.

Some doubt, it is true, has been thrown upon his explanation, owing to the fact that in all the cases the limb had been severely hurt; and the suggestion has been offered that these changes are really due to inflammation, which spread from the seat of injury to the affected joint; but it is admitted that there is no evidence that anything of the kind had occurred. According to Teissier, unbroken rest can be the only cause; and in this he is strongly supported by Bonnet of Lyons, who came to the same conclusion after a series of experiments expressly bearing on this point. It is admitted that the position in which the limb is retained is of some importance; that some joints are more liable to be affected in this way than others, those farther from the trunk more frequently than the nearer ones, the fingers, for example, more often than the wrist; and, further, that the changes are most conspicuous in the aged, or in limbs that have been paralyzed; but the main fact itself, according to them, admits of no dispute.

Even supposing the consequences of long inaction are not so extensive as this, they may still be sufficiently serious to lead to grave discomfort and suffering. It is certain that, in old people at any rate, a rest of comparatively short duration is enough to cause great stiffness, especially when the wrist

and fingers are concerned. These show the effect more rapidy than other joints, possibly because the movements they execute are so numerous and complicated; even in a few days the power of bending them may be completely lost; they remain rigidly extended, and the least attempt at forcing them, no matter how gently it is done, gives rise to severe pain, and meets with a sense of resistance which is not due to muscular contraction.

It is often said when this occurs that the patients are gouty or rheumatic, and that the stiffness is due to their diathesis; but there is no evidence of it. It comes on without aching or pain, that is not felt until after manipulation; the skin is not hot; there is no swelling or sign of inflammation; the onset is imperceptible; and the patient is unaware of anything being wrong until the hand is released from confinement and some attempt made to move it. There does not seem any other reason possible but the want of use and the prolonged rest in the straight position.

Changes in the Tissues Due to Prolonged Rest.—When the time is short these are not very conspicuous. There is less fluid in the joint, and its quality sometimes appears to be altered; it is not so viscid as it ought to be; but it is rare to find anything more. The tissues themselves do not seem to be affected as they are at a later period, and recovery is generally rapid. Afterwards there are other alterations; the loose and delicate connective tissue that fills up all the irregularities and interspaces becomes affected. In some parts it is compressed until it becomes dense and hard; in others it is filled with fluid, and becomes soft and pulpy. Then, as the bones and muscles move, and the pressure shifts from one point to another, the uneven tension causes pain. Instead of the tissues yielding smoothly and evenly, accommodating themselves to each other so that no unfair pressure falls on any part, some are hard and resistant, having completely lost their flexibility; others are swollen and distended, so that they cannot give way. The effect, if force is used, is much the same as when a ligament or any other band of connective tissue is stretched beyond its natural limit; the part swells up and becomes painful; the temperature rises; and if the attempt is repeated sufficiently often, the changes become more and more marked until they insensibly pass into inflammation.

In some of the older cases the results are even more serious. The capsule shrinks, and becomes rigid; or, owing to the relaxation of the muscles, loses its tone, and is unduly stretched; the secretion of the synovial membrane is completely altered; the softened parts in the tissues, where there has been no pressure, become, as it were, accustomed to the increase in the size of the space in which they lie, and fill it up entirely; those, on the other hand, that have been compressed, waste away, so that when the two surfaces of the joint are moved apart there is nothing to fill up the interval, unless the surrounding tissues are crushed in by outside pressure. The cartilages grow thinner and thinner; the ligaments shorten, and hold the bones in rigid apposition; the muscles degenerate, and, accommodating themselves to the fixed length at which they are kept, either contract and become converted into a kind of fibroid tissue, or waste and stretch. The tendons, too, at length become glued to their sheaths, and refuse to move; the skin loses its elasticity and suppleness; there is a blue congested look about it; it does not move freely or easily over the structures beneath, but seems shrunken on to the bones, as if it were too tight, and all the soft tissue underneath had gone. Even the bones waste, and become so thinned that a comparatively slight degree of violence may cause them to give way.

In the Fingers and Ankle.—This may happen when the joints are perfectly healthy in all other respects. The fingers have been already mentioned. There is scarcely a fracture of the arm or forearm in which a certain amount of stiffness is not left afterwards. It is not that they have been hurt in any way; they have merely been kept confined in a straight position, under pressure, without being allowed to move, and when released they are found to be stiff and rigid. The same thing occurs in the ankle joint when a patient is confined to bed during the course of a prolonged or exhausting illness. The foot is kept constantly pressed down by the weight of the bedclothes into the same straight line as the leg, and at last becomes fixed in that position; the muscles on the back of the leg become rigid and shortened; the ligaments on the front of the joint are elongated and stretched; and when the patient begins to get about he finds that he is unable to place the sole of the foot flat upon the ground, and, not unfrequently, is com-

peled to undergo a long and tedious course of treatment before the displacement can be rectified.

Not the Result of Injury or Inflammation.—It is quite true that this condition is more common after injuries than anything else; but it must be recollected that they are by far the most frequent cause of confinement in one position. It certainly may occur independently of them, as well as of inflammation; and it cannot be considered a peculiarity of old age, for though it is more often met with in people who have passed middle life, slight degrees of it, sufficiently severe to cause considerable inconvenience, though they yield more readily to treatment, may be found in all periods.

Faulty Position.—Malgaigne has offered the suggestion that stiffening of joints from rest alone is due not so much to confinement in one position (for then it would be more common even than it is in cases of fracture), but to the fact that the position is unsuitable, and, therefore, hurtful. In his opinion, unbroken rest, combined with extension in the straight line, is the immediate cause. The natural position of repose, in which the ligaments are relaxed, lies between the extremes of flexion and extension; if a joint is kept for any length of time rigidly straight some of the ligaments are loose, others are in a state of constant tension. The former gradually shorten, and become rigid and unyielding; the latter stretch, and grow weaker and weaker, or even at last become inflamed, owing to the unnatural condition in which they are maintained. In either case, the suppleness and flexibility are lost, and when an attempt is made to move the joint, pain is caused owing to the fact that the tension falls unfairly on them.

It is not unlikely that this is correct in the main, and that if a joint is perfectly healthy there is not much fear of its becoming stiff, unless the limb is kept in such a position that unfair traction is maintained continuously on ligaments which are not suited to resist it. The important fact is that it may occur—indeed, that in some circumstances it will occur—even when a joint is absolutely sound. If it has been sprained, if the ligaments and the capsule are softened by exudation, and by the changes in the circulation that of necessity take place after injuries, continued rest is almost certain to produce it in a very severe form. The length of time need not be great; very few days are sufficient; and the actual alteration in

structure need not be of great extent; a fold of the capsule may be thickened, or some of the synovial fringes matted together, or there may be merely some induration in the soft tissues, or filling up of the bursal spaces on the outside of the joint, a state of things that may be produced in a few days at the most; it is quite enough to prevent the free action of the joint and to give rise to severe pain if the attempt is carried too far.

In the majority of instances joints that continue stiff and crippled for such a length of time after being sprained show nothing more than this, and it does not appear to be much. There is no heat or redness of skin; the swelling is only such as would be accounted for by the extravasation of blood at the time, and the amount of exudation that is needed for repair afterward; there is none of that throbbing, burning pain which can rarely be mistaken; and there is no sign of inflammation. The reason that makes it so serious is, that when once this condition is set up, unless proper steps are taken to prevent it, there is a constant tendency for it to grow worse and worse. The adhesions and contractions that develop during prolonged immobility cause the softer and more delicate structures to be strained and bruised whenever an attempt at movement is made. Probably, if they are forced to give way once for all, the good that is done far exceeds the harm; but this rarely happens. Much more often either the sufferer does not move the joint at all, so that it is kept rigid longer still, or, if he has sufficient fortitude to persevere, makes matters worse by half measures. The shortened structures are merely stretched and strained, the part becomes swollen again, a fresh amount of exudation is thrown out, the adhesions grow thicker and stronger, and the joint is doomed to a further course of rest under the impression that it is inflamed.

Movement and Inflammation.—On the other hand it is urged, even by those who admit that inflammation is not an absolutely necessary consequence, that it is almost certain to be produced if the part is moved too freely or is used too soon. They agree that, unless there are other causes at work, sprains are not more likely to set up an attack of inflammation than simple fracture or any other form of subcutaneous injury; but they insist that it is absolutely necessary to keep the part at rest for fear of its setting in. It seems to me, however, that in

laying down a rule of this kind it is advisable to be more precise with regard to the extent and character of the movements executed, and the object with which they are performed. The danger of inflammation does not arise from slowly and carefully moving an injured joint once or twice a day; the liability to its occurrence is not increased in the least by this. An attack may be brought on by some peculiarity of constitution, such as gout or rheumatism, or by some morbid condition of the blood, inherited or accidental; or it may be caused by tension if blood or any other fluid is allowed to collect unchecked in the synovial spaces or the tissues round; but it is scarcely possible to imagine that, once or twice in the course of a day, slowly and firmly straightening out a joint that has been sprained could produce any such result.

It is not intended for a moment that anyone should be allowed to do what he pleases with his limb. There is a popular idea that injuries of this kind can be walked off, that only provided the joint is not allowed to rest for some considerable time no ill result will follow; and there are always to be found people ready to declare that they themselves have done it time after time without hurt of any kind, and that they have recovered more quickly in consequence. Sprains that admit of being cured in this way can clearly be only of the very slightest description; for such as these it may answer well enough, but it would scarcely be advisable to try it where the tissues have been seriously injured, or where the swelling and extravasation are of any extent. It is impossible to imagine that the repair of a ligament that has been torn in two or wrenched from its point of attachment to the bone can be assisted by such a proceeding. It may be of service where the strain has fallen on the muscles only and has not been sufficiently severe to tear any of their fibres, or where the effusion is limited to some of the muscular interspaces outside the joint; in others it is a method of cure which is only too likely to end in disaster.

Passive Movement.—It by no means follows, however, that the extreme opposite course should be adopted and the limb maintained in a state of absolute immobility. It is quite possible to move a sprained joint sufficiently to prevent the occurrence of stiffness or the formation of adhesions without causing the least pain or suspicion of inflammation. The first thing is to check the swelling of the part; if this can be pre-

vented passive movement may be carried out with no more than a sense of inconvenience. The pain, throbbing, and risk of inflammation are due to the distention of the joint and tissues round, and to the continued traction exerted on the nerves. If this is stopped at the first the joint may be quietly, but firmly, flexed and extended without causing anything deserving the name of suffering, and without any fear of reproducing the original accident.

Movement undertaken with this object must be passive, not carried out by the patient. Active movements are effected by the contraction of the muscles, acting in their ordinary course, and are executed for some purpose, or in opposition to some resisting power; passive ones, on the other hand, are carried out by some other force, as when one person bends and extends the limbs of another who exerts no strength himself; or when the finger joints of one hand are worked by means of the other. The bones are moved one on the other; the tendons play backward and forward in their sheaths; the folds of the synovial membrane and of the capsule are alternately straightened out and compressed; the pressure points in the tissues are shifted as they are in normal action; and, what is especially important for maintaining their vigor, a certain amount of traction is put upon the muscles and nerves; but no work is done. The joints are treated as complicated pieces of machinery, each part of which is moved by some external force, in a direction, and with a range, that can be limited with the greatest nicety. If one of the restraining ligaments is torn or hurt, no stress need fall on it; if the soft tissues on one side are bruised, they need not be pressed upon; and if a muscle has been ruptured, its ends are not more widely separated from each other. Everything can be regulated with the greatest accuracy.

Time for Movement.—The sooner this is begun the better. It is very rare for the tissues on both sides of a joint to suffer to the same extent. Those on one aspect may be torn, those on the other bruised, from the way in which they are crushed together when it is twisted; but the latter recover long before the former, and are capable of carrying out all their ordinary work at a time when a comparatively slight strain would tear the others in two again. As a rule, passive movement may be commenced from the second day with the certainty of pre-

venting adhesions, and without the least fear; it can be regulated much too well to allow any tension to fall on the injured part.

This answers especially well when the ligaments have suffered most. As a rule, these structures cannot stretch; their function is solely to prevent movement being excessive or passing some definite limit. So long as the range of action is kept within its normal bounds no strain falls on them; they are merely straightened out or unfolded, as it were. When a joint is sprained the movement is carried beyond this, and the ligaments, unless they are strong enough to resist the momentum, yield and give way; but even after this has happened, if the part is prevented from swelling, it may be made to execute all ordinary movements without fear of hurt, provided it is handled carefully by one who knows how much may be done.

It need not be said that hap-hazard or careless movements must be absolutely forbidden. The most accurate diagnosis is necessary to make certain what structures have suffered and what have not; and there must be a thorough and exact acquaintance with the action of the joint, so that the right kind and right degree of movement may be selected; but provided this is done there is no reason why the joint should not be worked in this way from the very first. If it is carried out thoroughly adhesions cannot form.

If a tendon has been dislocated, and the sheath of fibrous tissue which maintains it in its groove torn open, or if one of the cartilaginous discs which exist in some joints, such as the knee, has been displaced, the part may be exercised without fear of reproducing the dislocation or of delaying the union of torn fibres. In the ankle, for example, it is not uncommon for the tendons on the outer side to be displaced forward on to the bone. They are, ordinarily speaking, held firmly down by a fibrous sheath thrown over them, and lined with a delicate synovial membrane; sometimes this is torn, and the tendon escapes from its bed. When this has once taken place a single incautious movement on the part of the patient, before the sheath has had time to repair itself, may tear it open again and reproduce the dislocation; and if this happens more than once it is not improbable that repair never will be carried out; that the sheath will remain loose and yielding, allowing the tendons to slip backward and forward with the slightest

twist until the use of the corresponding muscles is practically lost. But if passive motion is employed systematically and carefully by some other person, who knows what the injury is, and how best its ill-effects may be avoided, the joint may be exercised thoroughly, flexed and extended as far as is desirable, and the nutrition of the muscles permanently maintained without the least fear of this untoward complication.

Even in the most severe sprains, when the staining due to the extravasated blood reaches, as it often does, nearly up to the knee-joint, it is advisable to begin on the second, or, at the very latest, on the third day. All that is necessary is that the whole of the swelling should have been dispersed by careful bandaging, or by other means. The foot is then to be released from all constraint, the skin and the subcutaneous tissues thoroughly kneaded, and the joint quietly, but firmly, flexed and extended several times as far as it is ordinarily in walking. This should be repeated every day until recovery is perfect, the limb in the meantime being as carefully and methodically bandaged as it was at first.

At first, no doubt, there is considerable apprehension on the part of the patient, and probably the muscles are unconsciously kept rigid and resisting; but this is easily overcome by kneading and steady, gentle pressure. Gradually, as the fear of being hurt diminishes, the movements become more and more free until all that is wished can be executed without distress. Pain ought scarcely to be felt. Of course, if a ligament has been torn off the bone, and direct pressure is exerted on the spot, it is felt acutely; but these are the places that should be carefully avoided, especially at first. After a little manipulation the tenderness generally diminishes considerably. If the swelling has been thoroughly dispersed, so that there is no tension on any part of the capsule or the tissues round, and if care is taken not to move the joint, so far as to put undue strain on a ligament that has been stretched or torn, the nerves are not dragged upon or compressed, and the movement is practically painless.

The ankle joint, owing to the plan of its construction, is peculiarly well suited to this method of treatment. Sprains are nearly always caused by the foot being suddenly twisted to one side or the other, so that the greatest strain falls on ligaments, which in all ordinary movements, are only moder-

ately tight. The slightest attempt at bending the foot laterally, in the direction of the original twist, causes the most intense pain, and all the muscles round become involuntarily rigid. All ordinary movements, on the other hand, are allowed to take place from the first, without the least resistance, after the natural feeling of apprehension has been overcome.

I have repeatedly seen the most severe cases treated in this way recover so completely in the course of a few days, that, unless there was an exceptional amount of walking to be done, the patient could follow his ordinary occupation without danger and without pain. Of course, if a ligament is torn across, a certain amount of time is required before it can unite, and still more before it can be firm; but the position in which the structures are placed by this plan is unquestionably the most favorable for speedy recovery. The ends lie in close apposition to each other; no external force is allowed to separate them, and, what is much more important, the synovial cavity of the joint is not allowed to remain distended with fluid, keeping the torn surfaces continually apart. If this is carried out fairly and consistently from the commencement, it is impossible for the joint to become stiff. Adhesions between contiguous surfaces are effectually prevented by the passive motion. The free manipulation renders any rigidity or contraction of the capsule impossible. Unless there is some other predisposing influence, inflammation is equally out of the question. There is no tension to excite it, and, if the compression is properly carried out, there can be no dilatation of the blood-vessels to pave the way for it; nor need there be any fear that afterward there will be that peculiar sense of weakness and insecurity which is so common as a consequence of sprains. In by far the majority of instances this is due to distention of the capsule or yielding of the ligaments; or, when this does not occur, to the fact that the muscles, from being so long unused, have become stiff or rigid, and do not respond as actively or as vigorously as they ought.

CHAPTER IX.

FORCIBLE MANIPULATION.

FEW modes of treatment have had a more curious history than forcible manipulation as applied to stiff joints. Often, for years together, in the greatest disfavor, owing, it must be admitted, to indiscriminate application, and almost discarded, it has always managed to retain a foothold in some part or other; and every now and then, when its mishaps have been forgotten, has sprung up again into notoriety, under, perhaps, some change of name. Very few minor operations are capable of giving such instantaneous and striking relief. It often happens that, as a result of some simple manipulation, a joint that has been crippled and the seat of pain for weeks and weeks is suddenly and completely released; but, at the same time, it must be remembered that, unless proper care is taken in the selection of cases, very few operations can do more harm, and also that it is not always easy to lay down rules by which the choice is to be guided.

Adhesions must be Divided or Torn.—If a joint is stiff and rigid from shortening in the fibrous tissue round it, there is only one thing to be done, only one plan of treatment that holds out a reasonable prospect of success: the contracted tissue must be either divided or stretched. Nothing else is of any avail. Baths, whether hot, or cold, or douche; galvanism, massage, friction, counter-irritation, blistering, and the numberless other remedies so often employed, are of little or no service. It is true that the circulation and nutrition of the part improve under their use; the muscles recover their tone and firmness; the skin becomes more healthy in appearance, and the general aspect of the joint is altogether different; but if, when the muscles were relaxed, the movements were stiff and constrained, they will continue in this condition, no matter how energetically these methods are carried out. They are

necessary as accessories; in fact, they are almost indispensable as a means for educating the muscles and nerves, so that they can exert their power again as soon as freedom of movement has become possible; but of themselves they can do little or nothing toward getting rid of the stiffness when there is the least degree of change in the fibrous tissue.

This has been learnt by dint of experience of the roughest kind. The strange idea that sprains are nearly always followed by inflammation (though it is admitted that it rarely results from any other form of subcutaneous injury), and the dread of causing a fresh outbreak by rough handling, have, to a great extent, deterred those who felt the responsibility from adopting more active measures. At least, this seems to be the most reasonable explanation of the fact that, at the present day, though means for making an accurate diagnosis are so much better than they were, and though it is so easy to avoid the infliction of pain, so little is accomplished by this method, and so many people are content to get about, as best they can, with joints which, at the most, have only partially recovered. Even then it is not easy to understand why there should be such objection. Supposing for an instant that inflammation were a much more common consequence of sprains than it really is, it is very unlikely that an attack would be caused by moving a stiffened joint within its natural limits, especially when every precaution is being taken to prevent its occurrence. The popular treatment is absolute rest; but though this, as already mentioned, is necessary under certain conditions, it must always be remembered that a joint can never become healthy so long as it remains unused.

Division.—Of the two methods I have mentioned, the first, division, is very rarely required in the case of simple sprains. Sometimes, it is true, the muscles on one side of a limb become so hard and rigid from long disuse that they refuse to yield to any reasonable amount of force, and then something of the kind must be done; but this is not common. It may occur in the ankle, when a patient has been for some time confined to bed, with the weight of the clothes resting on the front of the foot, constantly pressing it into the same straight line with the leg. When this happens, the muscles at the back of the calf grow more and more rigid, until, if proper steps are not taken to prevent it, they become permanently contracted. If an

attempt is made to move the joint against them, it feels as if two bony surfaces were being driven against each other; it does not yield in the least; the foot is hopelessly fixed, and there is no alternative but to divide the tendon.

Structures that require division are rarely situated close to a joint. As a rule, they have little or nothing to do with its synovial lining, or even with the loose fibrous tissue outside the capsule. For the most part they are attached to distant points, and are either thickened portions of the fascia, which have undergone passive contraction, or tendons of muscles shortened from disuse. These have to be divided before any thing further can be done; but though this is not unusual after a joint has been inflamed, it is rare to find such extensive changes after mere sprains. In any case it is necessary to examine the limb thoroughly beforehand while the patient is under an anæsthetic. It very commonly happens that what is apparently absolute rigidity disappears at once when the muscles are relaxed.

When division is required it must be carried out in accordance with the ordinary rules of tenotomy. A preliminary course of kneading is frequently of great benefit; it loosens the subcutaneous tissue, and makes the skin more supple and yielding; but care must be taken to give the part a complete rest for at least two days before. The fewer the number of punctures, and the smaller the size, the better, so long as it is done thoroughly. Very often, after beginning, it is found that, independently of the superficial bands, there are deeper ones beneath, the presence of which could not be ascertained before; whenever it is safe, they must be treated in the same manner. In all cases the punctures must be allowed to heal before the least degree of extension or manipulation is attempted, for fear of tearing the skin, as this is often exceedingly thin over such parts. In general, four or five days are sufficient. Then, if firm pressure is made with the thumb over the point of section, while the part is being manipulated, the newly-formed fibrous tissue between the deeper structures is easily made to yield without fear of injury to the rest. Failure of union, when a tendon or a band of fascia is divided in only one place, is quite exceptional.

Manipulation.—Manipulation is much more useful than division; it can be employed for such a variety of purposes. In

the early stages it prevents the occurrence of stiffness or the formation of adhesions. Later, when the swelling and heat have disappeared, it is no less successful in restoring freedom and ease of movement, and afterward, when all mechanical obstructions have been cleared away by its use, it is one of the most effectual methods known for bringing back the circulation and nutrition of the part, and giving again to the muscles and nerves the energy which has so long been wanting.

When the object is to set free a stiffened joint, it may be applied in one of two ways. The first aims at breaking down all obstacles at once by a few vigorous but well-directed movements; the second merely attempts to stretch the contracted tissues, little by little each day until they cease to act any longer as an obstruction. The principle is quite distinct. Each plan has its own advocates, but it is especially urged against the former that it is a rough and hap-hazard method of proceeding, likely to excite inflammation, and always liable to do more harm than good.

Rapid.—In certain cases no doubt this may occur. There are plenty of instances on record in which limbs, and even lives, have been lost by reckless manipulation. But this is entirely due to the fact that the cases were unsuitable, and that sufficient precautions were not taken.[1] When carried out properly and scientifically, rapid manipulation is not only more efficacious, but is more free from risk than the slow and tedious process of stretching the opposing tissues little by little.

Strange as it may seem at first sight, there is scarcely anything in the proceeding itself that can cause inflammation. Tearing across bands of fibrous tissue is no more likely to produce it than breaking a bone or dividing a tendon. There is little that is different and nothing that is exceptional in the nature of the injury. A certain amount of blood is extrava-

[1] The following instances in which manipulation was either attempted or proposed are mentioned by the author of one of the most recent and complete works on Diseases of the Joints (Howard Marsh) as having occurred under his own observation:—Malignant tumor of the thigh; malignant tumor of the shoulder; disease of the spine; three cases of scrofulous disease of the knee-joint; hæmorrhoids; and a case in which, after the hip-joint had already been excised, it was gravely declared that the bone was out, and must be replaced. The list could easily be extended.

sated; the vessels dilate; more lymph is poured out to repair the damage; but unless there is some grave constitutional affection present in addition, or it is followed up by serious maltreatment, this is no more likely to excite inflammation than a single bruise or subcutaneous laceration in any other part of the body. The capsule of a joint is always extensively torn in dislocations, but they are never followed by inflammation unless some similar cause is present, and it is difficult to understand why it should be so much feared when the injury is so much less.

Slow and Gradual.—Repeated straining, on the other hand, constantly attempting to stretch the contracted tissues, is one of the surest ways of exciting it. It does not matter how carefully it is managed. Each time a stiffened joint is gently worked the fibrous bands that check its movements are stretched, and very likely slightly torn; each time, in short, the tissues are sprained again, so that they become more and more tender and swollen. One of two things then must happen. Either the interval before the next attempt is not long enough for them to recover, the heat and swelling never have time to subside, and the joint becomes inflamed, though it does not regain its freedom, or for fear of such an untoward occurrence manipulation is abandoned for a time, thorough rest enjoined, and all the improvement lost; the bands regain their strength, and the stiffness becomes worse than it was before. One method aims at restoring perfect freedom at once with a single risk; in the other the danger is incurred again and again, each occasion being worse than the one that preceded it, without the chance of recovery being nearly so good

Accidental Bone-setting.—I must not be understood to advocate indiscriminate employment of forcible movement in all cases alike; it is just this which has brought it into such disrepute, and caused such an amount of opposition; only where other things are equal, adhesions in connection with sprained joints are far better broken across, once for all, than repeatedly strained and stretched. There is no difficulty in supplying examples in proof of this. One I have mentioned already while describing the changes that occur in the tissues round a joint after injury, and it is by no means a solitary, or even an unusual, case. A very similar one was narrated to me a short time since by another patient. According to his

own account, he had fallen down, with his arm outstretched, some time before, and (as was very probable) had dislocated his shoulder. It was reduced by a surgeon, but, for fear of reproducing the dislocation, the arm was kept bandaged close to the side for nearly six weeks. At the end of that time he could scarcely move it, and was almost convinced from the stiffness of the joint that the dislocation had never been reduced at all. It got better, however, by slow degrees, until he was able to move his arm in all directions, except upward and outward; the least attempt at this was stopped at once by a sharp stab of pain on the inner and under side of the joint. This continued until one day, about four months after the original accident, falling down again in much the same way, he felt a sudden snap, which hurt him intensely for the moment. Probably this was due to the rupture of a band, or of some contracted portion of the capsular tissue; at any rate, he found to his astonishment that his arm was from that moment practically free. Nothing afterward could turn him from the belief that the same kind of fall had both dislocated and reduced his shoulder joint. It was certainly wonderful that he did not dislocate it a second time.

In the ankle, when it is left stiff and painful after a sprain or fracture, manipulation carried out in this way is always worth trying. The particular kind of case in which it is likely to be successful can often be recognized at once. The skin over it is red and shining, as if it were stretched too tight; the color disappears readily when it is pressed upon, but is very slow in returning; firm pressure often causes it to pit, especially where there is a large amount of subcutaneous tissue; at the same time it feels cold to the touch. There is no displacement or dislocation; the outline of the bones is quite natural, though all the depressions are partly filled up, and the prominences rounded off; and the tendons can, generally speaking, be traced to their grooves. The position, however, is awkward, so that when standing upright the sole cannot rest flat upon the ground; movement is limited, and exceedingly painful at certain spots; and there is constant aching, especially at night or after any exertion. In several cases such as this, by putting the patient under an anæsthetic and working the joint thoroughly, I have succeeded in restoring perfect freedom of movement, sometimes at the first attempt.

It is essential to recollect in dealing with this part that though the original injury may have appeared to be confined to the ankle, the other joints of the foot rarely escape entirely; and that even if they are so fortunate, they have been kept continuously at rest as much as the ankle, and have undergone similar changes. For want of this precaution, I have seen more than one case fail at the first, and only succeed when the manipulation was extended to the others too.

Sprains of the wrist, again, often leave the fingers stiff and rigid for weeks, long after all heat and swelling have disappeared. In a case recently under my care the patient had fallen, about three weeks before, down a flight of steps, bending his right wrist-joint beneath him. According to his own account, he lay for some time (how long he scarcely knew) unconscious; and on coming round found that his arm was intensely painful, and that there was an enormous amount of swelling over the back of the hand and wrist, extending some distance along the forearm. This was reduced by careful bandaging, so that when I saw him it had almost disappeared, though there was evidence in the staining of the skin by the elbow how severe the injury had been. The hand was quite cool and painless so long as it was left alone, but he had not the least power over his fingers; they lay nearly straight, not apparently hurt, slightly swollen it is true, so that the shape of the joints was too rounded and uniform, but with nothing else about them to show that they had been injured. With the aid of the other hand he could almost bend them down into the palm, though it gave him a considerable amount of pain; but as soon as they were released they sprang back again almost mechanically. He was directed to have the part thoroughly kneaded and steamed for a few days; and at the end of the week was placed under an anæsthetic, and every joint in the fingers and wrist systematically worked through its full range. The next day the hand felt very sore, and was slightly more swollen, but this soon disappeared under massage. Movement was slow, and executed with great deliberation, but the range was much wider, and he was encouraged to use it freely. Two days after full power had nearly returned, and he was able to resume his work.

Where Rapid Manipulation is Suitable.—The joints in which this plan of treatment is most successful are those which

are cold, but not much wasted, where the adhesions are still recent, and especially where, from the pain and tenderness being constant at one spot, there is some probability of the contracted tissues being limited in extent. Hinge joints, in which the movements are, comparatively speaking, simple, and take place only in one plane, can be treated much more easily than ball and socket ones, or those in which the variety of movements is more extensive.

An anæsthetic should always be given unless there is some special reason against it. Not only does it render the operation painless, but by insuring that the muscles are relaxed, it enables the maximum result to be obtained with the least degree of violence. In many cases, indeed, it is necessary, in order to make the diagnosis exact; so long as the muscles are contracted, it is often impossible to give an opinion either as to the strength or the extent of the adhesions. The obstruction itself may be of the slightest description, and the limb so rigid as apparently to have lost the joint altogether. No ordinary degree of force may produce the least effect; but as soon as the contraction of the muscles is done away with, the mere weight of the part is sufficient to separate the adherent surfaces, and restore perfect freedom.

Preparation.—When some time has escaped since the accident, and the circulation is feeble, or when the skin and the subcutaneous tissues appear thin and shrunken, it is not advisable to attempt this without a certain degree of preparation. The joint should be well steamed, or douched with water from a jet of moderate diameter, commencing with it fairly warm, and finishing up with cold; or it should be thoroughly kneaded every day, for a week or a fortnight, to loosen the skin and bring back the circulation. No pains should be spared to insure this. Great stress is laid by some on the use of oil, which is to be well rubbed in; and certain kinds are much more highly recommended than others; but in all probability the beneficial effect is entirely due to the friction. A small quantity of oily matter is no doubt absorbed, but it is impossible to imagine that its action under these conditions is mechanical, as this would imply.

The operation itself is not so simple as might be imagined. It is true that occasionally the most extraordinary recoveries are effected by falls or other accidents; but it must always

be remembered that these are only heard of when they are successful; and that, very probably, they are quite the exception. In the majority of cases failure is much more likely, unless a definite and well-ordered scheme is followed out.

Method.—The chance of success is greatest when the obstruction can be accurately localized. No pains should be spared to effect this. The joint must be thoroughly examined in every position it can be made to assume; any spot that is tender must be marked beforehand; the movements that cause an increase in the pain must be noted, both as regards direction and extent, as well as the least irregularity or unevenness as one part glides over another. It is entirely owing to their power of appreciating minutiæ of this description that some persons have acquired such a reputation for the treatment of these cases.

The patient must be placed so that the portion of the limb between the affected joint and the trunk can be fixed securely by an assistant while the lower part can be freely moved by the operator. In the case of the larger joints, one hand should grasp the limb immediately below, so that the thumb may press firmly on any spot that is tender; the other must be sufficiently far off to secure a proper amount of leverage. All rapid movements should, so far as possible, be in the direction of flexion, combining with it abduction, adduction, or rotation, according to the case, so that the tension may be directed to the required spot.

To carry this out effectually two things are needed beyond all others. The one is a sense of touch so delicate that it can appreciate the least resistance or irregularity of movement; the other an accurate knowledge, not merely of the ordinary anatomy of the part, but of the different degrees of tension that fall on the ligaments in every position of the limb.

Each joint requires a different kind of manipulation according to its construction. In the case of the shoulder, for example, the elbow must be bent so that the forearm may be used as a lever, and the arm rotated first to one side then to the other, bringing it across the chest and carrying it round behind the back before any attempt is made to raise it from the side. Bringing it up at once would very likely dislocate the joint. For the knee Hood recommends the foot of the affected limb to be held by the operator between his thighs,

so that when flexion is accomplished by the hand it may serve as a lever for rotation. This, however, can be effected by the hands alone if the muscles have been relaxed by an anæsthetic. The smaller hinge joints can be managed even more easily, flexion being combined with lateral or rotatory movements so far as the shape of the bone will allow.

There should be no jerking. The movements must be vigorous and forcible, but perfectly smooth; and they must be carried out thoroughly, the joint being moved to its full extent in all directions that are natural to it. Each kind of action should be combined successively with the rest, one by one, so that the tension may fall in turn upon all the different parts of the capsule.

Movements which are especially restricted or painful of course require most attention, but the others, though they may not be affected to the same extent, are not to be neglected. It sometimes happens if these are dealt with first that a considerable proportion of the main obstruction is cleared away, as it were, by side attacks, so that when its turn comes it yields more readily than it otherwise would.

Recent slight adhesions give way at once without a sound, though the sensation is generally conveyed to the hand. When they are older the noise may be as loud and clear as when a bone is broken. Probably in many cases this is due not so much to the actual tearing of adhesions as to the sudden separation of two synovial surfaces that fit accurately into each other. The noise that can be produced in this way, especially if a table or other structure is made use of as a sounding board, is well known.

The after treatment of these cases should be in all respects the same as that of a recent sprain, only if passive motion at an early date is advisable to prevent the occurrence of stiffness in the one, it is absolutely necessary in the other. The joint must be worked systematically every day from the first. If the adhesions have been thoroughly broken across, and if swelling is prevented by compression, it is almost painless. In exceptional cases it may be necessary to administer an anæsthetic the first few times.

Manipulation as an Exercise.—This, however, is not the only use for forcible manipulation. Even when all adhesions have been broken down and the action of the joint thoroughly

re-established, voluntary power is often slow in returning. The joint itself may move with perfect freedom, but the muscles, and even the nerves, seem to have lost their power. It is so long since they have done any work that they have become unable to do any. They are wasted and shrunken in size; the circulation in them is defective; possibly their structure, even, has undergone some alteration. Whatever it may be there is no question that, when a case has lasted any time, their strength and vigor become seriously impaired. The joint cannot be considered cured merely because the mechanical obstacles to its action have been removed; something more than this is required. Recovery is not complete until the natural condition is restored, and the joint is able to undertake active work again.

Exercise, of course, is the most effectual remedy for this. When it can be carried out the cure is rapid and certain, but in many cases it seems impossible. Sometimes there appears to be an actual inability to make use of the muscles, as if the power of the will was unable to reach them. Sometimes the sense of insecurity is so great that the patient cannot be persuaded to place sufficient trust in them. Whatever the cause may be, forcible manipulation is of the greatest service in these cases, especially if it is helped by massage and galvanism. The way in which it is used is, of course, very different to that already described, and the object is different; in the one its purpose is to tear across adhesions, in the other to rouse latent muscular activity, but if used systematically, success, though, perhaps, not quite so conspicuous, is equally sure. Elaborate accounts have been written from time to time of what has been called the movement cure, and many varieties of manipulation have been described in connection with it, but, so far, at least, as the treatment of sprains is concerned, it does not seem clear that they possess any great advantage one over the other. The principle in them all alike is to exercise the muscles according to their strength, to stretch them out, and manipulate them without fatigue. In most cases the greatest amount of benefit appears to be obtained by making use of the different plans successively, beginning with that which calls for the least effort on the part of the patient.

Simple extension, gradually straightening out the muscles, one after the other, with some degree of force, until a distinct

sensation of resistance is experienced, is especially useful in the earlier stages, immediately after the adhesions have been broken down. Sometimes the muscles are irritable, and inclined to painful spasmodic contraction; or hard knots form in their substance, possibly due to rupture of a few of the fibres; or a certain degree of soreness and tenderness of skin makes itself felt over them. Whatever may underlie them, these conditions are often relieved by slowly but firmly extending, one after the other, the various groups of muscles that lie round the joint, and applying firm and even pressure.

What are known as resistive movements are of much wider application. In these the patient either carries out a definite course of action against the resistance of the operator, who is able to select any particular group of muscles, and regulate exactly the amount of work, or the latter makes use of his strength to oppose some voluntary action on the part of the patient, compelling him to give way. The former of these methods is by far the most useful of the two. The secret is to keep the opposing force well within the limits of the patient's strength, making use alternately of flexion or extension, or of rotation inward or outward, as the case may be. Exercise of this description certainly possesses wonderful influence on the nutrition and activity of the tissues, not the muscles only; and with a reasonable amount of care it may be kept up for a considerable time each day without overfatigue. The other plan tires out the muscles at once, and is too exhausting to deserve strong recommendation.

In some cases it is possible to substitute for the hand of the operator mechanical contrivances, arrangements of wheels and levers adjusted to resist any individual movement that may be wished, and capable of being graduated exactly by the patient to suit his own strength. The action, however, is not quite the same. The resistance of a spring or an elastic band cannot be graduated like that of human muscles, guided by an experience of what is required; and unless very carefully superintended the progress of cases treated in this fashion is apt to be very uneven and irregular.

CHAPTER X.

MASSAGE.

MASSAGE, again, which is a most valuable remedy in the treatment of sprained joints, has a history as strange as that of forcible manipulation. It has never been altogether forgotten; some people have always practiced it, more or less carefully, and with a varying degree of knowledge and skill; but at certain times, and in certain countries, it seems to have acquired an extraordinary reputation, and then, again, almost capriciously to have been as strongly condemned. Possibly fashion may account for it in certain measure, for this exerts an influence in the use of remedies just as it does over everything else; but something, at least, must be attributed to the indiscriminate and unscientific manner of its application by unskilled persons in all cases alike, whether they could or could not be benefited by it. Like many other things it has been destroyed by its own popularity.

It is certainly not a novelty; in most countries there has been handed down by tradition from unknown ages a custom of treating injuries of joints and muscles by friction or manipulation, and in some places this has been considered a special prerogative of certain families or individuals, who, by dint of long practice and a certain delicacy of touch (perhaps inherited), have attained no inconsiderable degree of skill. The modern plan is simply the scientific outcome of this; the working has been studied more accurately; its action on the tissues better considered; and certain rules laid down for guidance in the selection of cases.

At one time, for example, Beveridge's rubbers were well known in Edinburgh, and the success that attended their treatment (which was carried out very thoroughly and methodically) had a marked influence on the practice of the Continent. Then the process was almost forgotten, or, at any rate, was

rarely employed, except in country districts, where rubbing is often used, in a rough sort of way, without skill of any kind other than that derived from custom. Lately, again, owing in great measure to the exertions of Dacre Fox, in England, and Graham, Norström, Metzger, and others, abroad, it has been placed on a scientific basis, and received once more into favor. Even at the present day, however, there is too great a tendency to consider it a quack remedy, and to hand it over to persons whose chief recommendation is that they act as untiring rubbing machines, without following any definite rules or guidance.

It is often said against it that those who take it up abandon it again as soon as they have had sufficient experience of its results; they find, so it is alleged, that not only does it require a large amount of patience on the part of the sufferer, as well as the operator, but that it is only beneficial to those who would recover as soon without it, and that in some cases it is actually injurious. As a rule, and so far as sprains at any rate are concerned, this arises from the inability to distinguish massage from mere unskilled rubbing. In reality there is nearly as great a difference between them as there is between painting the wall of a house and the work of a skilled artist. The one requires a certain amount of muscular strength and manual dexterity, the other only comes to those who are by nature fitted for it, as a result of teaching and experience. It may or may not be true that it requires two years, as Dr. Murrell states, to learn the process; that depends on the person and on the previous training; certainly many do not acquire the art even in that time.

As a general application massage is very widely used. There are many descriptions copied from travelers' works of its employment in one form or another among most of the races of mankind. It was largely practiced by the ancients; the Turks and Africans at the present day make use of it; even among the Siberians and Laplanders it may be found in a form modified by the exigencies of climate; while the "lomi-lomi" of the Sandwich Islanders is spoken of in terms of enthusiasm by nearly every one who has written of them for its power of relieving the stiffness and soreness of excessive exertion, and procuring rest and sleep. The effect is described as most luxurious; the process is neither kneading, squeezing,

nor rubbing, but now like one, now like the other, each muscle is manipulated in its turn, beginning with the head and working down slowly over the whole body, until in half-an-hour the weariness has quite disappeared and given place to a most refreshing sense of ease and comfort.

Like many other words that have crept into science from popular usage, massage has scarcely yet acquired a precise or definite meaning. It has been used for every kind of manipulation, whether applied to joints alone or to the whole surface of the body, with the hands only, or with the assistance of instruments. All varieties of friction, pressure, kneading, percussion, and even passive motion, have been included in it at one time or another; and the description of the manner in which it is carried out, and the rules by which suitable cases are selected, are proportionately vague and uncertain.

For all practical purposes, so far, at least, as concerns the treatment of injured joints and muscles, the various processes that have been enumerated may be grouped under the three heads of friction, percussion, and kneading. Passive motion differs to such an extent in its object and method of application that it seems unwise to include it.

Friction.—Of these friction is by far the most simple, and the easiest and least fatiguing to carry out; but its power is very limited, and it has scarcely any direct influence, except on the most superficial structures. It consists merely in a succession of strokings with the hand (using as much of the surface as possible, and fitting it into all the inequalities) from the extremities toward the trunk, commencing lightly at first, and gradually increasing in strength as the part becomes accustomed to it. The knuckles even may be used where the tissues are very deep-seated, or unusually firm. The skin soon becomes red and warm; more blood flows through it, the temperature rises, and, after a few days' treatment, a distinct change may be noticed in the nutrition of the part. Instead of being hard and unyielding, tied down, as it were, to the subjacent tissues, the skin becomes soft and supple, the natural appearance returns, the folds become visible again, and the superficial tissues begin to regain their firmness and elasticity.

Besides this, however, friction exerts considerable influence on the nerves distributed to the skin, and indirectly through them on internal organs, especially on other parts of the

nervous system. The medium through which this takes place is not accurately known. It is possibly the result of the increased activity of the circulation, but more probably it is due to the peculiar sympathy existing between different parts of the nervous system, by virtue of which one cannot be stimulated or excited without influencing the rest. However this may be, of the fact itself there can be no doubt; friction, especially along the back, is often of the greatest service in relieving irritability or sleeplessness.

Combined with baths, and applied generally over the surface of the body, it is of excellent service when the limbs are aching and stiff from over-exertion or exposure to cold. It allays the sensitiveness of the skin, leaves behind it a feeling of well-being and comfort, and does away with the sensation of fatigue. In sprains, however, and injuries of like character, its application is more limited. In recent cases, where there is no extensive laceration of ligaments, and where it is thought advisable to begin massage without delay, it may be used as a preliminary to allay the sensibility of the skin, and accustom the patient to firmer kneading. In old chronic cases, too, where the joint has not been moved for some length of time, it is of undoubted use in restoring the natural tone to the skin before more active measures are undertaken. In other circumstances it is rarely employed for injuries of joints, though it is highly recommended as part of general massage for other disorders.

Percussion.—Percussion, too, whether carried out by means of an instrument or with the hand, is of very limited use. Unless applied with such force as to cause actual bruising, it has no direct influence on any structure deeper than the skin and the subcutaneous stratum of muscles. On the former it produces the same general result as friction, though without its soothing influence; on the latter it acts as a local stimulus, causing each time a single contraction of the fibres beneath, varying in extent and vigor according to the condition of the muscles. To produce the full effect, the movement must be rapid and short, the pressure being raised at once. The weight of the blow must be regulated by the depth of the structure. Great stress is laid by some on the number per minute, when percussion is used for the relief of pain or neuralgia; but, so far as the muscles are concerned, this does not

seem material, though it is as well the strokes should not be too rapid.

The effect is most marked when the muscles are in a state of tension, though the actual shortening produced in these circumstances may be less apparent. When, for example, the lumbar region is being percussed, the patient should stoop forward, so that the muscular slips lying along the side of the spinal column may be placed upon the stretch, and receive the full effect of the vibration. Otherwise a considerable amount of the benefit is lost before the muscular substance is affected at all.

Massage.—Massage, in the strict sense of the term, is a great deal more efficacious, especially with older sprains. Its action is not limited to the skin and superficial structures. These undergo immense changes, it is true; they become softer and finer while under manipulation; their strength and elasticity increase, the extreme tenderness diminishes, and the natural appearance and texture return. The surface loses its dry harsh character and becomes warm and moist again; the livid bluish color gives way to a brighter hue, and the deeper layers of fibrous tissue yield and stretch, so that the hide-bound shrunken condition that is often present after long disuse gradually passes off. But the good effect is not by any means limited to, or even most conspicuously shown by this. When properly carried out massage exerts a simultaneous influence on muscles, nerves, and vessels, in fact on all the tissues within its reach.

The circulation is the first thing to feel its power. It has already been explained how, after prolonged rest, the blood, as it were, lies almost stagnant in the tissues, slowly circulating through them, and neither giving them sufficient for their nutrition, nor removing from them the waste products of their action. This is changed at once. The life of the part is quickened. The veins and absorbents are emptied first, and the fluid they contain driven on to the heart, which fills more rapidly, and contracts more vigorously and firmly. Then the pressure falls on the smaller vessels, and the tiny irregular spaces, full of lymph, which extend in all directions through the tissues. These, in their turn, are compressed and mechanically emptied, their contents being driven on into the empty vessels, from which any backward flow is prevented by

the valves. The circulation becomes more rapid; nutrition is carried on with greater energy, and the actual amount of blood in the tissues at any one time so much increased that they become full and soft to the touch and regain the even and rounded contour of active health.

Next to the skin the muscles seem to experience the greatest amount of benefit. Even after a single application they are capable of doing a great deal more work with much less fatigue. It has often been shown that a muscle, exhausted by lifting a heavy weight many times in a minute, scarcely regains any of its power if it is merely allowed to rest a quarter of an hour. It remains stiff and weak, and liable to irregular and spasmodic contractions. If, on the other hand, it is treated by massage for the same length of time, its strength returns, so that it is able to do as much again with even less fatigue than it felt before.

At the same time the sensitiveness to electric stimuli is increased. Murrell has shown that a current, too weak to cause any response when applied to the motor point of one of the muscles of the arm, is able to produce vigorous contraction after a few minutes' massage. The excitability of muscles, and the amount of energy they are capable of putting out, are regulated—other things being equal—by the way in which they are supplied with food, and the rapidity with which the waste products are removed. This, in its turn, is dependent on the circulation. Each muscle and each bundle of muscular fibres is surrounded by a sheath of fascia, to all intents and purposes quite inelastic; under this is collected the fluid plasma which is the immediate source of the nutrition of the tissues. So long as the muscle is at rest this remains unchanged; when it contracts, so that the shape and consistence are altered, or when the muscle itself is thoroughly and systematically kneaded, the fluid is driven onward into the lymphatics and at once renewed from behind. It is for this reason that massage, so far from causing fatigue, is of such service in relieving it.

The good effect does not pass off at once. If the treatment is continued and a proper supply of food maintained there is a lasting increase in the size and condition of the muscles. Instead of being soft and flaccid or stiff and unyielding, with hard and tender nodules in their substance, so that they rather

impede movement than otherwise, they become firm and elastic to the touch, ready to respond at once to any stimulus, and able, when called upon, to put out a much greater amount of energy.

It is hardly fair, however, to attribute the whole of this improvement to the condition of the muscles only. Massage exerts a similar influence on the nervous system, and though the immediate results may not be so striking in their character, the actual changes are none the less important. During the process itself, and often for hours after, the patient experiences a sense of refreshing ease and comfort. Lassitude and pain disappear; the capacity for work returns, and mind and body alike regain their vigor. Probably this results in no small measure from the improvement in the circulation, as the effect at first is quite local; but from the way in which general strength and voluntary power are restored, in what are known as neurasthenic cases, massage must exert a very considerable influence upon the whole of the nervous system.

In Recent Injuries.—The best proof, however, of the power it possesses over absorption and circulation is shown by the ease with which the swelling and tension can be made to disappear from sprained joints. It is true that in recent cases the greatest care is required, and that nothing is so likely to increase the mischief as rough handling of the part; but when it is carried out quietly and gently, by one who has had some experience, it is very difficult to find anything that acts in so perfect a manner. The whole limb, perhaps, is swollen; the joint distended with blood; the skin shining and tense, much too hot to the touch, and exquisitely tender; but all this vanishes almost like magic. The tension disappears as the fluid is carried off; the pain is relieved, the temperature falls, the natural outline begins to be apparent once more, extravasated blood is broken up, the *débris* dispersed, and adhesions between the torn and bruised surfaces effectually prevented. Sometimes even tendons, which have been turned almost out of their grooves by the accumulation of fluid in their sheaths, can in this way be restored to their position without further assistance.

Such results as these cannot, of course, be obtained in every case of recent sprain, and even when the treatment is successful in relieving the pain and getting rid of the swelling, it

must always be remembered that time is needed for the repair of structures that have been torn. I am convinced, however, that, especially when the stress of the injury has fallen on the muscles, and when the laceration is not too great, this plan may be adopted, not only with the greatest safety, but with an infinitely better prospect of speedy recovery than under the old established method of bandaging and rest. Graham, in particular, lays stress on the fact that the sooner the treatment is commenced after the injury, the shorter its duration is likely to be.

In Older Cases.—In older cases, where the effusion is denser and firmer, and where, owing to the long-continued distention, the tissues have lost their tone, and become sodden and œdematous, massage can be used with much greater freedom. The solid part of the effusion is broken up and disintegrated by the pressure, so that it is driven into the absorbents and carried away by the increased force of the stream; the chronic congestion is dispersed, the blood circulates more freely, the tone of the part returns, and the lifeless, helpless look disappears day by day. The improvement is often surprising in its rapidity. A joint that has remained for weeks cold and inactive, the seat of a constant wearing pain, and quite incapable of performing its proper movements, in a very few sittings begins to recover its flexibility, loses the pain, and allows itself to be handled, and passive movements to be carried out with ease and readiness.

Active movement, in general, takes some time longer, for the muscles grow so stiff and rigid from prolonged disuse that they require as much education as the joint itself. The case that furnishes the most striking cure is a sprained joint that has been treated by bandaging in the conventional way, where the œdema still persists, and where there are no adhesions round other than those caused by the rigidity of the capsule and the swelling of the soft tissues. Even if weeks have passed, the effect may be seen after the second or third sitting. Only where, owing to the great length of time, the effusion has become thoroughly organized, and where the structures round are shrunken and matted together by dense, unyielding fibrous tissue, it is of little avail until the joint is set free, and full range of action restored by vigorous passive movement.

Method.—The method of application is not easy to de-

scribe, and it can only be learned through practice, even by those who already possess a fair knowledge of anatomy. This is indispensable; without it, massage must degenerate into mere rubbing. Each group of muscles must be known, where it ends and begins, how thick it is, and how the tendons lie, where the intermuscular septa of connective tissue come, and where the vessels and nerves that supply the part are situated. All the natural movements and the different arrangement of the structures in various positions of the limb must be perfectly familiar. The synovial cavity of the joints and the tendon sheaths must, as it were, be mapped out underneath the skin. In short, there must be a thorough practical knowledge, not only of the anatomy of the part at rest, but of the direction and mutual relations assumed by the different structures when at work.

Supposing the case of a sprained ankle of moderate severity in a healthy person, a few hours after the accident the ligaments are strained, perhaps even slightly torn; the synovial cavity is distended with fluid, the tissues round are swollen out with extravasated blood, the skin is hot and discolored, the normal shape of the joint is lost, and all the hollows between the bones are filled up. The patient must be seated comfortably, so that the muscles are, as far as possible, relaxed; the knee must be bent, and the foot and ankle given over altogether to the manipulator. The foot is to be held gently but firmly, so that the patient may make no incautious start, and the whole proceeding from first to last should be entirely devoid of pain. The operator should have plenty of room, so that he is not cramped; perhaps as convenient a position as any is kneeling on one leg, or sitting on a low seat in front of the patient, with the heel of the injured limb resting on the front of his knee. The movement at first must be exceedingly light, and so directed as to diminish as much as possible the sensitiveness of the skin, commencing with the part above (nearer the trunk) the injured joint, and working gradually downward. The thumb, or the tips of the fingers, or the palm of the hand, should be used according to the shape of the surface, taking care always to employ as much as possible.

The direction of the movement must always be toward the trunk, from the insertion to the origin of the muscles, in the direction of the returning current of the circulation, com-

mencing over a part where the swelling has not yet shown itself, and gradually working on to the rest. The most tender spots must always be left till last. If, for example, the foot has been twisted outward, there is nearly always great sensitiveness over the tip of the internal malleolus, and a considerable amount of swelling along the course of the tendons behind, extending a variable distance up the leg, and into the hollow in front of the tendo-Achillis. This must be left until friction has been applied over the whole of the rest of the foot and leg; if this is carried out thoroughly not only does a great deal of the swelling disappear of itself from the injured part, but owing to the condition of the circulation through that which has been already manipulated, the remainder is absorbed much more readily than it otherwise would be.

Gradually, if the treatment is persevered in, the tendency to start on the part of the patient, and even the involuntary shrinking, disappear; the foot is given up to the operator with greater confidence, and the superficial general swelling begins to diminish. More attention may then be paid to the spaces in which the extravasated blood has collected to the cavity of the joint and the tendon sheaths. The tips of the fingers, or the thumb, may be made to trace out the irregular intervals between the bony prominences moving round and round in small circles on the skin. The two hands should be used close together, so that the paths the fingers traverse intersect each other, and the manipulated surfaces overlap. Gradually, as the effusion subsides, the circles increase in size, the pressure becomes firmer, and the deeper-lying structures are treated in their turn. The individual muscles and tendons are grasped and squeezed in the direction of their fibres, the fingers being always carried onward toward the trunk in the interspaces between them; and the soft tissues are firmly pressed, and, as it were, rolled along by one hand after the other, until all the excess of fluid has returned once more to the blood stream, and slight passive movements of such a nature as not to exert any traction on the injured ligaments are allowed without resistance.

This is to be taken as the sign of success in the treatment of recent cases. How long before it is reached differs naturally in each individual, and no rule can be laid down. Sometimes in slighter injuries a single short sitting suffices; at

others the process must be repeated for several days. The time that has elapsed since the accident, the condition of the joint, the degree of swelling, and the severity of the pain, all possess some degree of influence. As a general rule, if the injury is recent, there is more tenderness about the part, but the swelling disappears sooner; in older cases firmer pressure may be used from the first, as the skin is less sensitive; but the time before the swelling is absorbed, and movement becomes free and painless, as a rule is much longer.

At the close of the sitting the joint and the limb must be bandaged with pads of cotton wool, so arranged as to fill in all the natural depressions of the part. If they are held in place with a flannel, or better a Domett bandage, the joint may be moved a little, though the pressure is sufficient to prevent the return of any great degree of swelling and œdema. But, however carefully the bandage is applied, it nearly always happens that the next day some of the fullness and tenderness of the part returns, so that another sitting is desirable. If the case is going to terminate favorably, each application is shorter and less painful than the last, and each time the range of passive movement is increased.

It must clearly be borne in mind that, though this method of treatment causes the swelling to disappear more rapidly than any other, and allows the return of slight degrees of movement without pain almost from the first, a ligament that has been torn across requires nearly as long for repair as when it is left alone. Consequently, when it comes to the question of dealing with sprains of great severity, such as often are met with in the ankle, all that is done, and, indeed, all that can be done, is to restore the parts to the condition best suited for repair, and to guard, as far as possible, against the after troubles of stiffness, chronic œdema, and pain.

In older sprains, the method of application is somewhat different. Here much less stress is laid upon light friction, and much more upon deep manipulation and rolling of the parts. The object is not so much to cause the absorption of a fluid exudation as to stimulate the muscles and nerves to greater activity, and to increase the amount of blood and lymph circulating through the deeper strata. The grasp is firmer, and the pressure greater; the whole hand is used, and both at the same time; if, for example, the limb is not too large, one may

be placed opposite the other, so that two groups of muscles are manipulated together, the fingers of one hand partly reaching on to the territory of the other. One hand contracts as the other relaxes, each, in its turn, squeezing the tissues onward and away from the middle line, and stretching the parts that lie between them. Care, of course, must be taken not to stretch the tissues in opposite directions at the same time; and it is a wise precaution to go over the surface gently and superficially before attempting deep or thorough manipulation.

Where other joints are concerned, the treatment must be conducted on essentially the same principles, varying the details according to the circumstances of each case. The operator should always keep sufficiently far off so that his movements are not cramped or constrained, and he should always endeavor to make use of as much of the surface of his hand as possible. The fingers must be kept close together for the sake of mutual support; they should not be allowed to slip too much upon the skin, which should move with them as far as possible, or the operation may be a very uncomfortable one for the patient. For this reason ointments and other similar applications are very rarely used unless it is wished either to diminish friction or to produce some specific effect.

The patient must be placed in an easy and comfortable position, with the limb well supported, and, where possible, well raised, so as to assist the return circulation. If, for example, the wrist is the part in question, the point of the elbow should be resting on the table; if it is the elbow itself, or the shoulder, the patient should either rest his hand on the shoulder of the operator, or should even lay hold of something higher still.

The hands must always lie in the direction of the muscular fibres, and the rolling and squeezing always tend upward from the extremities toward the trunk. The rate of movement and the amount of force that is used must vary with each individual; but there should never afterward be any sign of bruising due to the manipulation. It is always present, of course, to a greater or less extent, in recent sprains, and it is nearly certain to be there if adhesions are broken down or a joint is forcibly manipulated under an anæsthetic; but it never occurs after massage unless the force used has been ex-

cessive and unjustifiable, and its presence generally means that more harm than good has been done. Instead of assisting in the repair of the damage it has inflicted more.

It is most essential to commence as gradually and as gently as possible, only working on the deeper tissues after the more superficial ones have become thoroughly accustomed, and have been unloaded of their surplus fluid. The skin, the soft subcutaneous tissue, the muscles, and the deeper layers, must all be worked in turn. Nor should the manipulation be confined to the injured part. In a sprain of any standing the whole of the limb is affected more or less. It is usually better to devote attention first to the parts nearer the trunk, than to deal with those around the injured area, and only afterward, when the circulation is thoroughly re-established, to manipulate the joint itself.

The tendency is to make the sittings last too long. Deep manipulation itself rarely requires more than five minutes; but in dealing with a recent injury it may be advisable to spend a longer time than this over the friction and other preparatory measures, so that a quarter of an hour soon passes by. When the tenderness is very great, and the amount of swelling excessive, much longer than this may be necessary, but short, frequently repeated sittings are of greater benefit than one long one. A skilled operator, too, will often effect more in a few minutes than an ordinary rubber will in as many sittings.

CHAPTER XI.

SPRAINS OF TENDONS.

SPRAINS of tendons are deserving of as much consideration as those of joints; they are almost as common; the changes in the tissues are nearly as serious, and the results, though they vary a good deal, are in many respects quite as important. Unless perfect freedom of movement is regained, there is an amount of suffering and inconvenience often altogether out of proportion to the extent of the mischief.

Structure.—In one respect the question is much easier; the structures concerned are not nearly so complicated. The shorter tendons are merely unyielding bands of various shape, directly connecting the muscle to one of the adjacent bones. They are formed of tough fibrous tissue, continuous, on the one hand, with the membrane investing the bone, and, on the other, spread out to receive the attachment of the muscular fibres. The longer ones are more or less rounded in shape, and are inclosed in a synovial sheath, practically identical with that which lines the interior of joints. The surface is as smooth as it can be, so that the tendon glides without friction in its groove, no matter how many bends or curves it makes, or how often the position and direction of these vary in different movements of the limb. The interior is lubricated by a fluid identical in character with that in joints, just sufficient in amount to fill up all the interstices, and enable the sheath to fit closely and evenly round the tendon. The outer wall is formed of a fibrous layer, which, though apparently distinct (just as the capsule of a joint appears distinct), is only a layer borrowed, as it were, from the delicate tissue round. Owing to the friction, this is condensed into a firm membrane, smooth and polished on its inner surface, but rough on the outside, where it still retains its connection with the fibrous tissue from which it was formed.

In some parts of the body each tendon has a separate

sheath surrounding it like a tube. At the ends this is continuous with the sides of the tendon, so that the cavity is completely closed. It is largest and best developed where there are projecting points of bone, and where the direction of the pull is consequently altered. In many parts the sheaths of two tendons lying side by side communicate with each other; and where, as in the wrist or ankle, the number of those running in the same direction is considerable, there is only one large sac surrounding them all. Sheaths of this description are much stronger and stouter, the walls are thicker, and owing to the bundles of tendons lying side by side, each moveing independently of the rest, are ribbed, as it were, on the inner surface with longitudinal ridges, which sometimes project as actual folds, inclosing between their layers a mass of soft and delicate tissue well supplied with minute vessels. In the young the lining membrane itself is quite smooth, so far as its inner surface is concerned; but as age advances, particularly in those whose work is laborious, or whose joints and tendons are exposed to heavy or repeated strains, it undergoes great alterations. The folds grow stouter and longer, their free margin becomes irregular and broken up into fringes, and the tissue of which they are composed becomes tougher and firmer, until in some instances the surface is as irregular and as shaggy with villous processes as the interior of a joint affected with chronic synovitis.

Effects of Age.—This, however, is not the only alteration found in tendon sheaths after adult life. There is a slight but constant tendency for them to enlarge and encroach on surrounding structures. Where two lie side by side, or where one is in contact with the capsule of a joint, the dividing wall in course of time grows thinner and thinner until it gives way altogether, so that the cavities communicate with each other. In other instances, where the tissues round are soft and yielding, the sac expands unevenly, and becomes covered over with irregular dilatations. If the wall is especially weak at any one spot, or if from some accident the fibrous layer of the sheath has been torn, the lining membrane is forced out little by little into the interspace, until it assumes the shape of a pouch, opening into the sheath by means of a long and sometimes very narrow neck. When one of these is once formed it generally continues to increase in size. Fluid is driven into it

with very considerable pressure every time the tendon moves without there being any corresponding force to insure its return; the sac grows larger and larger until it projects beneath the skin, or even opens up a communication with some more distant cavity. It is in this way that tendon sheaths become connected with neighboring joints, the pouch developing originally sometimes from the one, sometimes from the other.

In the majority of instances it is difficult to say how far these changes are the result of time alone, and how far they are the product of repeated sprains, and of attacks of rheumatic gout. In joints there is no question that these causes are of material assistance, to say the least. Whenever large diverticula are present, or the interior of the synovial membrane is more than usually irregular, one or other of these has been at work. The same is probably true of tendon sheaths and of bursæ; the alterations are not serious except under these conditions. Slighter degrees, however, tending in the same direction, but not going further than a moderate amount of dilatation and thickening, are so common, and so consistent with what takes place under the same conditions in similar structures, that there is no doubt they are due, in part at least, to the natural degeneration of the tissues occurring everywhere as age advances.

Extent of Injury.—The tendons themselves rarely sustain much injury in the case of sprains. They are formed of little more than tough bundles of fibrous tissue closely woven together, so that if they escape being torn in two, or wrenched from the muscle to which they belong, they generally escape altogether. The sheaths, however, in which they lie make up for them in this respect. They are so delicate in structure that they are torn or bruised by the least unusual strain, and the relation they bear to the tendon they inclose is so accurate that the slightest alteration is sufficient to produce a very considerable effect.

Overwork.—Serious consequences are, of course, much more likely to be produced by violent injuries, but mere overwork is sufficient to affect the synovial lining and to cause inconvenience and actual pain. It need not be excessive; it is enough that it should be more than usual, and that it should be kept up for some time. Instances of this are of every-day

occurrence when an unusual degree of exertion falls on a group of muscles that are not accustomed to it. The movements of the tendons are no longer easy and natural; a hot, burning sensation is felt each time the muscle contracts; there is a feeling of tenderness and fullness over it; the temperature (as taken by a surface thermometer) may even be slightly raised, probably from the larger amonut of blood that is flowing through the part; and, what is the most striking and characteristic symptom of all, as the tendon plays backward and forward in its sheath there is communicated to the finger a delicate sense of crepitation and rustling, as when two surfaces of silk are being rubbed together. Sometimes this is perceptible to the patient himself, at others it can only be elicited by carefully applied pressure over the tendon sheath. Whenever it occurs it may be accepted as clear proof that there is some alteration in the relation between the tendon and the membrane round it. Naturally it can be felt most plainly where a number lie close together beneath the skin, as on the front of the ankle joint or the back of the hand. In situations such as these, any unaccustomed degree of exertion, walking, for example, some distance unusually fast, or feathering in rowing at the commencement of the season, or even carrying a heavy weight in the hand, is sufficient to cause it.

Tenosynovitis.—It has been imagined by some that this peculiar sensation is the result of the sheath becoming dry. The synovial fluid is, as it were, used up, and the movement of the tendon over the dry and roughened surface causes friction. It is very difficult to understand how this can occur; such a condition of things would be almost unique; nowhere else does use, even when carried to the greatest excess, entail any similar result. The immediate effect of muscular contraction is to increase very largely the amount of blood flowing through the part, and to cause a much larger quantity of lymph to pour out through the walls of the vessels into the surrounding tissue spaces. It is difficult to understand how, under such conditions, the sac of the synovial membrane could become dry. The walls contain a greater amount of blood, they are softer and thicker, the lining layer of cells is not so perfect, their growth is more rapid, so that they have no time to assume their normal flattened shape, and the character of the fluid in the interior is modified by being mixed with the exuded lymph

and with the cast-off cells; but the quantity is rather increased than diminished.

Lawn Tennis Arm.—The same symptoms (with the exception of the rustling) are produced by over-exertion when the tendon is attached directly to bone without the presence of any investing sheath of synovial membrane. A common instance of this is met with in a variety of what it is the present fashion to call lawn-tennis arm, though a similar thing was described long since in Australian diggers. There is a tender spot about the middle of the forearm, on the outer side of the bone, corresponding to the attachment of one of the muscles that is used especially in back-handed strokes; and sometimes the tenderness is so great that I have known it the source of great uneasiness. The skin appears slightly swollen and raised above the normal level; but it is quite white, even whiter than the surrounding part, and the swelling so soft that it can be appreciated much better by the eye than by the touch. In moderate cases it is limited to this point, and the muscle itself is not affected; only when it contracts there is a feeling of soreness and stiffness, not, perhaps, amounting to actual pain. In severe ones the swelling extends over the whole muscle.

The changes here are essentially the same; owing to the increased wear and tear more blood flows through the part; a larger amount of exudation is poured out into the tissues, through the walls of the vessels; the skin becomes more highly sensitive, so that it feels sore and tender when even light pressure falls on it; and the action of the muscles is difficult and painful. Only there is no crepitation or rustling, because there is no synovial sheath in which the fluid can collect.

Muscular Strains.—Under some circumstances the exertion required to produce such a result may be exceedingly trivial. It is not uncommon for patients who are recovering from an attack of severe illness, when they are allowed to sit up for the first time, to complain, after an hour or two, of soreness over certain bony prominences, and of a sensitiveness of skin that is sometimes mistaken for hysteria. There is a line, for example, at the back of the head, or a space between the shoulder blades, where the least pressure is painful, especially after they have been sitting up some time. In the morning, or after a long rest, nothing of the kind is felt; the muscles can act freely and naturally. It is only when they are tired out

that these symptoms begin to appear. The work that they are called upon to perform is too much for them; they have been weakened to such an extent by prolonged illness and want of exercise that the exertion of sitting upright is as much out of proportion to their strength as severe and prolonged labor would be if they were in good training. There is, it is true, no appreciable amount of swelling, but it is quite sufficient for the purpose that the tender points of bone correspond with very fair accuracy to the attachments of the muscles that receive the strain. Rest at once relieves it, and as the nutrition improves and strength returns the symptoms rapidly disappear.

The same thing is frequently met with in connection with the abdominal muscles after vigorous efforts of any kind, and it is sometimes so marked that I have known it mistaken for more serious disorders, especially as the muscles are often thrown into a state of cramp, so that they do simulate, to some extent, internal tumors. There is the same burning sensation when contraction takes place; the skin feels tender and sore, and its sensitiveness is extreme (as it frequently is in hysteria), the patient wincing at the slightest contact. Sometimes the feeling of soreness is worst over the points where the muscles are attached to the bone; but more often the patient refers it to the junction of the muscular and tendinous fibres; and it is remarkable and very characteristic of this muscular overwork, that nearly always, in indicating the seat of the pain, the patient moves his hand, quite unconsciously, in the direction of the fibres that have had the severest strain.

Injury to the Sheaths of Tendons.—In sprains, however, the trouble is generally more serious, and the symptoms more definite. When, for example, a man falls down with his hand and forearm doubled up beneath him, so that the whole of the stress falls on the tendons at the back of the wrist, and the soft and delicate tissues lying underneath are crushed against the bone, the amount of damage sustained is not to be mistaken. Within a very few minutes the wrist swells up, the tissues are bruised, the vessels torn across, and blood poured out into the tendon sheaths and the structures round, just as it is when any other part of the body is injured. Only because there is a sac in which the fluid can collect, the swelling is unusually rapid in making its appearance, and is limited at

first in shape. Soon, however, it begins to spread; the back of the hand swells up, though here it always feels softer than it does elsewhere; then it extends along the forearm, and even makes its appearance on the front of the wrist, probably because the tissues in this situation were crushed and squeezed at the moment of the fall. The skin becomes hot and tender; movement at the wrist is completely lost; the joint is kept nearly straight, and can neither be bent nor extended; the former movement is too painful, because then the extensor tendons are pressed against the part of their sheath that has already sustained the severest hurt; the latter is almost impossible, as tendons cannot work when their sheath is distended with fluid. Even the fingers suffer in the same way; though a certain amount of flexion is permitted, they cannot be bent into the palm of the hand or completely straightened out.

After a few days the bruise begins to come out near the elbow (generally on the front surface of the joint) and, perhaps, in the hand; the coloring matter from the blood soaks by degrees into all the surrounding structures, and spreads along the looser planes of cellular tissue until it reaches the skin. The swelling slowly diminishes, remaining longest over the tendons; the tenderness becomes more definitely localized, being chiefly felt over that part of the back of the wrist which corresponds to the spot where the tendons were most bent and crushed against the edge of the bone; the movement becomes more free; the amount of grating and creaking grows less and less, and if no adhesions have formed, and there are no other troubles to hinder the progress of recovery, voluntary power slowly comes back, though even in a moderately successful case it is sometimes months before all the thickening has disappeared and the joint can be completely flexed.

Inflammation.—Sometimes it happens that instead of the extravasated blood being absorbed, and the movements returning in this way, inflammation sets in either as the result of some constitutional predisposition, such as gout, or from the excess of tension in the tissues. Ordinarily speaking, it is not present at all. The changes which have been described above are identical with those that accompany any severe bruise; the swelling has been already accounted for; the increased amount of blood flowing through the part, causing the skin to become hot and sometimes red, and making it at the

same time more sensitive to pressure, is only what is required by the increase in the need for repair; the pain is due to the tension caused by the extravasation and effusion; and the loss of mobility is the result in the early stages of the distention of the sheath (for unless the tendon is tightly grasped it loses all its power) and of the pain when the torn and bruised tissues are pressed on; in the later ones, of the imperfect absorption of the lymph that has been thrown out and of the stiffness caused by prolonged rest. These are the great causes of the delayed convalescence and of the obstinate rigidity that so often follow such injuries. In the majority of instances there is no more inflammation after these than there is after a simple fracture or a severe bruise.

When it does break out the severity of the symptoms is not easily mistaken. The pain is intense; it is no longer a question of a hot or burning sensation felt when an attempt is made to move the tendon; the whole extremity throbs from one end to the other. The temperature rises rapidly; the skin grows red, and, if suppuration is going to follow, becomes thick and swollen, so that it pits on pressure and can no longer be raised up from the structures that lie beneath. At the same time there is high fever, with headache and constitutional symptoms of great severity.

Inflammation of this description rarely remains limited to the space in which it begins. Sheaths of tendons and bursæ are, so far as their development is concerned, merely great interspaces in the cellular tissue, and they never lose their connection with the others around them. If they become inflamed, and their contents suppurate, the way lies open for the pus to spread through all the cellular tissue of the limb. It may even extend into the neighboring joints without there being of necessity any direct or open communication between them. I have many times seen complete destruction of an articulation, even of such a one as the knee, occur as a result of deep-seated suppuration that had found its starting-point in the inflammation of a neighboring bursa or tendon sheath.

Imperfect Recovery.—Imperfect recovery, stiffness, and loss of power are much more common. For a week or two everything goes on well; the symptoms gradually diminish in severity; the pain becomes less and less; the swelling disappears, except immediately over the tendons (there it always

lasts the longest), and a certain amount of voluntary movement is regained. But then the improvement stops. Every attempt at further progress is checked at once by pain, and is followed by an increase in the swelling. The muscles begin to waste; the neighboring joints and tendons become stiff from prolonged disuse; and sometimes the improvement already won is lost again, and free movement of the tendons never returns completely.

There is no doubt that this is much more likely to happen if the tendon sheath has been inflamed, and that then the results are, generally speaking, much more serious. Even when it subsides fairly soon, inflammation, if it once involves a tendon sheath, always leaves behind it extensive, and sometimes permanent, changes. But it is also certain that loss of movement, and other troubles, are met with after injuries of tendons in which inflammation never occurs at all. Complete and permanent wasting of the muscles, and an absolute degree of rigidity, may be uncommon; but, independently of these, sprains are liable to be followed by a number of other consequences, which have nothing to do with inflammation, and which are quite sufficient to give rise to the gravest inconvenience, and even to prolonged suffering.

Stiffness, for example, is rarely absent altogether. Some time always passes before the tendons move, as they ought to do, so easily that there is no consciousness of their existence. Pain is equally common, and, indeed, is in general severe in proportion to the stiffness. It differs immensely in different cases. In some there is a constant sense of aching, and of soreness over the whole part, even when it is at rest. In others it is only felt on movement, and then with great severity over certain spots. Swelling nearly always persists for a time. The sheath is distended with fluid, or cysts develop in connection with it; or there is some effusion into the cellular tissue round, sometimes soft and yielding, at others hard and irregular. It may continue without material change for an almost indefinite time; more often it increases slightly in amount as often as the tendon is much used. The skin may remain exceedingly tender, especially over those spots where the swelling is greatest, or where pain is felt when the tendon is moved. Creaking and grating are almost universal. It is not merely the delicate rustling, already mentioned, due to the alteration

in the lining cells, or to blood or lymph being mixed with the synovia, but a much rougher, coarser sound, caused by the presence of fringes, projecting up from the folds of the lining membrane, like those in joints; or else by myriads of loose bodies floating about in the fluid, in which the tendon lies and moves. Louder noises even may be audible in the later stages, caused, in all likelihood, by the sudden separation of two surfaces that accurately fit each other.

Very often there is a peculiar feeling of weakness—not so much actual loss of power in most cases as a sense of insecurity. It occurs even with an ordinary ganglion on the back of the wrist, and is almost invariable when one of these is large enough to project distinctly under the skin. The patient complains of inability to use the hand, the flexor muscles being as much interfered with as the extensor, owing, no doubt, to the way in which they are always trained to act together. When the dilatation involves the sheath itself, the sensation is never wanting. I have seen an instance in which a patient was quite unable to bend his middle finger, merely because the sheath of the flexor tendons along the under surface was distended with fluid. There was no other obstacle; it could be bent by the other hand, as far as mechanical considerations would allow; and as soon as the fluid was removed by subcutaneous puncture, full power was regained.

Even this does not exhaust the list. There are other consequences following sprains of tendons, similar to those already described in the case of joints, involving parts that have not sustained any direct injury. Wasting, rigidity, and loss of power in neighboring muscles; stiffening of the capsules and sheaths of other joints and tendons; filling up of the cavities of bursæ and other periarticular spaces; and many others which are probably the result of prolonged rest and confinement in one position, rather than of anything else. Inflammation, when it does break out, makes them all tenfold worse; but it is not by any means necessary for their occurrence. The injury sustained when a tendon sheath is badly bruised, and then kept perfectly quiet for an indefinite length of time, is quite sufficient to account for them in most cases without calling in the aid of anything else.

Treatment.—So far as general principles are concerned, the treatment of tendons, after they have been sprained, is very

similar to that already described in the case of joints. The great object is to restore the power of voluntary movement as soon as possible; everything else must be subordinate to this. Until this is perfect, recovery cannot be said to be complete.

The first obstacle is the extravasation of blood into the tissues, and the amount of lymph poured out afterward to effect the repair of the injury. The soft and vascular tissues, some of the most delicate in the body, are crushed and torn; blood flows out in all directions, until, if it is not checked in some way, the sheath and the cellular spaces round can contain no more. Then all the vessels dilate; everything swells up and becomes soft; the interstices in all directions are distended with lymph, which gradually takes the place of the blood as this is absorbed; and if no steps are taken to prevent such a result, the tendon, its sheath, the delicate tissues round, and even the neighboring muscles and fasciæ, so far as the injury has extended, become glued together. Of course, the extent to which this change takes place in the different tissues varies within very wide degrees. The tough, unyielding, and almost non-vascular substance of which a tendon is composed scarcely shows the change at all, while the soft and delicate tissue round and between the folds of the synovial sheath is so altered that it can hardly be recognized; but the principle is the same. The change is an essential one, the natural consequence of the injury, and has nothing to do with inflammation. Under certain conditions it may be carried to excess, and then it becomes a source of danger, and may even, by the help of other agencies, become the starting-point of this complication, the cause rather than the consequence. But this ought never to happen, and if the effusion can be restrained within proper limits, and the predisposing causes are not too strong, never does happen. No doubt inflammation follows if a patient, who is on the verge of an attack of gout, by some fall, strains or otherwise injures one of his tendons. It is only natural that it should, and it may come on within an hour after the accident, but it is not fair to put this down entirely to the credit of the injury.

There is another reason for trying to check the effusion as soon as possible. After tendons have been sprained there is always a certain degree of stiffness. This is dependent on

many things, and cannot be helped at first. But the permanence of this stiffness, and its degree, are regulated almost entirely by the extent of the effusion, and by the changes that it undergoes. If it is slight and quickly reabsorbed, leaving only so much as is needed for the repair of the tissues, perfect movement is recovered spontaneously; but when it is excessive, and all the surrounding structures are softened and infiltrated, this can only happen under the most favorable conditions. As a rule, much of it becomes organized; and then all the tissues are made stiff and rigid, and are matted together by adhesions. The minute interstices between them, for the purpose of allowing free and even play of movement, are filled up. Probably during life they contain a semifluid material, so that the structures on either side can easily accommodate each other in their various movements; this quite disappears. In worse cases, the opposite surfaces grow together, and the tendon becomes adherent to its sheath, either in places, here and there, so that fibrous bands pass across from one to the other and limit the range of action, or even all over, so that recovery, so far as movement is concerned, is quite hopeless.

Pressure.—Heat or cold may be tried at first, as already directed in speaking of joints, but by far the most efficacious method is to apply well-graduated pressure from the very commencement. The details, of course, must vary in each case, but when this can be done systematically, not as bandaging ordinarily is, with the whole of the pressure on the bones, nothing succeeds so well. Only there must be a thorough knowledge, not only of the structure and arrangement of the parts, but also of the exact nature of the injury sustained in each case.

Massage.—Massage or kneading is even more useful in the treatment of sprained tendons and muscles than it is in the case of joints. The second day, when the pads and bandages are removed, the limb appears misshapen from the pressure to which the soft tissues have been subjected, and stiff from their confinement. Kneading and working the part thoroughly every day causes this to disappear more rapidly and more effectually than anything else. It must, of course, be done with a definite idea of the purpose in view, and with a knowledge of the structure of the part itself. Further, as the accident is so recent, the ordinary rules must be observed with

even more than usual care. The rubbing at the commencement must be very light, affecting only the skin at first, and then later the deepest structures. Tender spots must be approached very carefully; they need even more attention than the rest, but, unless it is very cautions, manipulation makes them more painful still. Every movement must be commenced at the end of the limb, working gradually toward the trunk. Properly managed, and used at the same time as passive motion, the relief this gives is immense; the pain is exceedingly slight; the swelling disappears more rapidly than it does under any other method, and the chances of after stiffness are materially lessened.

Passive Movement.—There are the same rules with regard to passive motion. It must be employed regularly and systematically every day without fail. The loose tissues round the tendon sheath are softened and thickened; the surface of the synovial sac is rough from the rapidity with which the new cells are formed to line it in place of the old ones; and it is irregular from the swelling of its folds and fringes. Unless movement is kept up from the first this must end in some degree of stiffness. It need not be repeated often at each sitting; once is quite enough, but it must be thorough. Every joint and every tendon near the part that has been injured must be worked at least once a day through its whole range of action. Slight and faint-hearted attempts, apparent movements really taking place at another joint, are useless, and throw discredit on the treatment. They do not prevent the formation of adhesions, or break down those that are already established; they merely pull and strain on the stiffened structures round, and make them painful and tender without setting them free. The adhesions, before they are too firm, are easily separated by definite and well-regulated manipulation without any fear of exciting inflammation. Even after they have become organized it is safer, as has already been shown in speaking of joints, to break them down thoroughly and effectually with one single effort than to keep perpetually straining and worrying them. Weak and ineffectual attempts, carried on hap-hazard, without any definite object in view, do more harm than good. They increase the pain that is left, cause more lymph to be poured out, prevent the absorption of that which is already there, and allow it to accumulate until, as the adhesions grow thicker

and stronger, the prospect of recovery becomes more remote than ever.

In the later stages, when the signs of bruising have nearly disappeared, if the movement of the tendons remains painful and constrained, and particularly if the patient can point out certain spots which are especially tender after use, more energetic treatment is required, just as in cases of imperfect recovery after sprains of other parts. Baths, douching, and shampooing may be tried with success in many instances. Tendons, even when very stiff, nearly always move more freely after long soaking in hot water, and though they may not retain the whole, there is nearly always a certain amount of permanent improvement. Galvanism, too, in these circumstances is sometimes of great assistance in encouraging the circulation and restoring muscular vigor. Stimulating liniments, especially those containing the aromatic oils, are also most useful as adjuncts. They increase the flow of blood through the superficial parts, soothe the pain, and loosen and improve the nutrition of the skin. In this way they are of assistance to other measures which they cannot replace. If there are large and tender muscular masses, which remain stiff and painful, acupuncture often acts with good effect, as described in speaking of sprains of the back; and counter-irritants and small light blisters, often repeated, are of excellent service in many of these cases. If, however, the tender spots are very definitely marked, and if they become more painful and tender regularly after certain movements, these methods are rarely sufficient to secure more than mere temporary relief. Something further is required.

More Permanent Changes, Adhesions, etc.—It may be that there is the residue of an old organized blood clot, outside the sheath altogether, forming a little hard, irregular mass, that is pressed on in certain positions when the tendon is stretched. I have known this it the neighborhood of the knee, in the fibrous expansion given off by the extensor muscle. It was merely a little blood clot, following a blow, lying underneath the fibres; but probably there was a nerve filament near it, for the least contraction of the muscle gave rise to an amount of pain seemingly out of all proportion. I have little doubt that the same thing sometimes occurs in connection with deeper tendons.

In other cases there is an adhesion, or some thickening on the tendon sheath, or there are fringes or loose bodies in the interior continually shifting their position, and keeping up a certain amount of effusion, by the way the sheath is bruised when the tendon moves over it. It is extraordinary what a degree of pain and tenderness may be caused by a body of this kind, whether in a tendon sheath or bursa. Quite recently a patient, a woman of middle age, with rather stout and shapeless limbs, was sent to me, complaining that she had received a blow on the knee about a month before, and that ever since she had suffered such an amount of inconvenience that she could scarcely get about. Walking had become very painful; going upstairs was bad, but coming down she had such a sense of insecurity that she was obliged to cling to the banisters, a statement which I have often heard when there was anything interfering with the action of the extensor of the knee. On examining the joint, it appeared slightly enlarged, but most of the swelling was below the knee-cap on each side of the ligamentum patellæ, caused apparently by the enlargement of the bursa, which exists naturally in this situation, and which is always larger and more prominent in women than it is in men. It was over this that she had received the blow, and here on firm pressure could be felt a large loose body, which, when the muscle was relaxed, slipped easily under the ligament from one side of the joint to the other, causing each time a very peculiar and sickening sensation.

In the same way I have on several occasions been able to trace the development of foreign bodies in the bursa lying in front of the knee-cap. In this situation they give rise to little inconvenience, as a rule, until in kneeling down and reaching forward the weight of the body is brought to bear upon the patella; then there is a sudden stab of acute pain, and within a few hours the bursa becomes filled with fluid. Sometimes there is only one, irregular in size and shape, but often, owing probably to the repetition of the injury before advice is sought, the number is very considerable; or if the first is due to injury, the others may result from the persistent degree of irritation, and even of inflammation, maintained by its presence.

When the pain can be traced definitely to a cause of this kind, there is no alternative. The patient must be placed under an anæsthetic to avoid suffering, and to secure complete

muscular relaxation; the part must be thoroughly examined and the adhesion, if one is present, broken down, or the foreign body removed. Whatever the cause of the continued tenderness may be, it very rarely happens that it is of a nature to be cured by prolonged rest. In the great majority of instances it is due to this having been too much prolonged already. Most of the crippled joints and tendons that are met with after sprains are due to the fact that passive movement has not been employed sufficiently early or sufficiently thoroughly; and they are only to be cured by the adoption of measures that must be energetic in proportion to the delay.

Ganglions.—Some of these after-consequences, ganglions, for example, require a certain amount of notice, as they either do not occur in connection with sprains of joints, or, when they do, must be treated in a special way. There are two varieties of these; one is a small cyst, originally in connection with the sheath, and probably due in the first place to a protrusion of the sac through a weakened or ruptured part of the wall; the other is a dilatation of the sheath itself. There is no essential difference between these, so far as their origin is concerned; they both frequently originate in strains, though it is possible some may arise from inflammation or in other ways; they contain the same kind of fluid, a clear gelatinous substance, much thicker than natural, and devoid of all lubricating power; and it is often possible to find transition forms between them, sheaths, that is to say, irregularly distended, so that they appear to be sacculated; but the symptoms to which they give rise, and the method of treatment to be adopted, are very different. The former are by far the most common, and occur with especial frequency on the back of the wrist, where they give rise to much annoyance by their unsightly appearance, and by the sensation of weakness that accompanies them. They are met with, however, as well on the foot, on the outside of the knee, just by the head of the fibula, and in other places; indeed, there is hardly a tendon sheath in the body from which they do not sometimes project. As a rule, the inconvenience they cause is not serious, but it is not uncommon to meet with instances in which neuralgic pain of a severe character is a prominent symptom, probably because some small cutaneous nerve happens to be pressed upon by the cyst in certain positions of the limb.

Simple Ganglion.—The ordinary method of treating these is to crush them by direct pressure, and then gradually squeeze the contents into the surrounding tissues, so that they may be absorbed, assisting the process from time to time by friction and kneading, or by the pressure of a leaden plate. Or they may be punctured, and the fluid let out, and if they fill again, injected with iodine, or a small seton passed through them. Or a small tenotomy knife may be introduced on one side of the cyst, and the whole mass divided in two by a horizontal cut; this answers better than the others, as it is impossible for the sac, when it has once been treated in this way, to fill again; but none of these methods are quite satisfactory. They often succeed, it is true; but, even when the cyst does not return, it is very common for a hard irregular mass to be left behind, interfering with the action of the tendons, and causing an unsightly tumor. I have known a swelling of this kind persist unaltered for twenty years in spite of continued attempts by kneading and other measures to get rid of it.

When it is desired to remove them thoroughly and finally, it answers much better to dissect them out. There is no difficulty unless they have been ruptured and squeezed several times before; they separate readily from everything round except the tendon sheath. Generally they are firmly attached to this, and often when the uniting band is severed the tendon may be caught sight of, lying in its groove, and showing that the cyst was in communication with its sheath. If the operation is done carefully, and the hand kept on a splint for a day or two after, the cure is effectual, and the scar can scarcely be seen at the end of a week. If, however, the cyst has been much handled first, particularly if several unsuccessful attempts at squeezing it have been made, it must be left for some time before attempting any such proceding.

Compound Ganglion.—It is more serious when the dilatation involves the sheath itself, especially if it is a large compound one, including many tendons, such as that in the palm of the hand, or if it is in the immediate neighborhood of a joint. Even where there is only a single tendon, and the size of the sheath is not very great, the inconvenience is often considerable; but in these cases the character of the wall rarely undergoes much change, and if they are not cured by blistering or tapping they are certain to yield to subcutaneous incision,

followed by pressure and passive motion. In the larger one the lining membrane and the contents have, generally speaking, undergone such modifications that it is often impossible to promise more than relief.

Like the others, their origin may sometimes be traced to a single strain, though it is more usual for them to develop as a result of repeated injury. In proportion to their number, communications with joints are certainly more frequent; but this, of course, is mainly regulated by anatomical considerations, and by the condition of the joints themselves. If these are affected by rheumatic gout, or if cysts develop from them for other reasons, it is all the more likely to occur. Sometimes the connection is due, as I have seen myself, to the enormous size of the ganglion; it grows larger and larger until the structures in between are so thinned by absorption that they give way, but more often, as Morrant Baker has shown, the reverse of this happens, diverticula form along tendon sheaths, or through weak parts in the capsule of joints, and appear perhaps some distance off as cysts which closely resemble ganglions.

The fluid in the interior may be identical with that found in the smaller forms, or it may be more liquid and less gelatinous. It develops in a very short space of time; I have found it present and of typical consistence within three weeks of a strain. The wall is usually much altered in character; in one instance it was in a condition almost identical with that met with in joints as a result of strumous inflammation, greatly thickened, that is to say, much too vascular, semi-translucent in appearance, and covered over on its inner surface with numerous little granulations. In other cases it is much tougher and firmer, and projects into the interior in great folds and fringes, which lie between the tendons, and seriously interfere with their action. Occasionally, the sheath is divided into chambers, and very often it contains numbers of minute bodies of the same shape and size as melon seeds. What these are formed of is not absolutely certain in all cases; it seems most probable that, in the majority, they are developed either from the fibrin of extravasated blood, or from lymph that has collected in the sheath, and has been worked continually backward and forward by the movements of the tendons. When they are present in any number the wall is, as a rule, coated

over and roughened with material of the same character, so that probably the latter explanation is correct. They contain no cells or fibres; on the addition of acetic acid they swell up so as to become translucent. All that can be made out is an indistinct concentric marking, as if they were formed of layer after layer of some fibrinous material.

Ganglions such as these must be treated on totally different principles to the smaller ones. Palliative measures are of little use; free subcutaneous division of the wall has been practiced with success in some of the simpler ones, where there are no melon-seed bodies; and in the case of the great palmar one, section of the ligament that divides it in two has been recommended, but I have had no experience of it. Generally speaking, the sac must be laid open freely, the whole of the fluid removed, together with the melon-seed bodies present, any partitions that exist, dividing the interior into chambers, thoroughly broken down, and even in some instances it is necessary to scrape the wall, so as to clear it from the adherent lymph. Then it must be drained so that it does not refill. Naturally this operation is a very serious one. There is great danger of inflammation setting in, and even if it does not, some permanent degree of rigidity, in spite of the early use of passive motion, is always left behind. If it does, the consequences may be disastrous to the very last degree.

Cysts that develop in connection with joints, whether as a result of injury or of rheumatic gout, or of both together, must either be left alone or treated in the same way. In this one would be guided mainly by the age and constitution of the patient, the condition of the joint as regards security and movement, and the size and rapidity of formation of the cyst. I have seen them in connection with the shoulder, ankle, and knees; and no doubt they may occur in other joints as well. Sometimes they caused but little inconvenience; at others they spread so rapidly, and attained such a size, that it was absolutely necessary to drain them. In nearly all there was a great deal of stiffness afterward, but this was due in part to the original disease; one of them suppurated.

CHAPTER XII.

SPRAINS OF THE BACK AND NECK.

SPRAINS of the back and neck are sufficiently common and important to deserve a certain amount of separate consideration. The structures concerned are exceedingly complicated; there is an immense number of separate joints of various shape and size, and in addition there is the spinal cord running in a canal down nearly the whole of its length, and giving off the nerves which pass out on either side between the bones. Nor do the injuries themselves vary less in character and severity. In some they are exceedingly slight; in others the consequences are as serious as any that occur in surgery. Some, too, have gained a most unenviable notoriety from their connection with railway accidents; for whatever may be the truth as regards many of these cases, whether they are deceptions or not, there can be no question that sometimes very considerable injuries are produced by the way in which the backbone, and the structures in connection with it, are strained and wrenched when the body is thrown violently backward and forward as it is in collisions.

One of the most singular features in connection with these sprains is the way in which the backbone itself, and the muscular and ligamentous structures around it, are overlooked and ignored. Even in the ordinary accidents of every-day life there is a great tendency to lay everything that is serious or lasting to the credit of the spinal cord. In railway cases there is no hesitation at all; if any serious result ensues it must be the consequence of damage this structure has sustained, or of inflammation following it; little or no attention is paid to anything else. Yet it is difficult to see why the other structures should enjoy immunity. The vertebral column may be strained, especially in the cervical and lumbar regions; the ligaments torn or stretched; the nerves bruised or crushed; the smaller

joints between the segments twisted and wrenched; the muscles detached from their bed and torn across, or thrown into such a state of cramp that they become rigid and unable to act with freedom; or the fibrous sheath which contains them and helps to secure the bones laid open and filled with blood. Results, in short, of the most serious description are not uncommon, and often leave lasting evidence of their existence behind, when the spinal cord itself escapes completely.

Injuries of the Spinal Cord.—When it is hurt the symptoms cannot easily be mistaken. There may be insensibility for a time even when the head is not injured. A certain degree of shock is always present, and when this has passed off there is paralysis or loss of power, corresponding in extent and degree to the amount of injury sustained. This may make itself apparent at once, or some time, even hours, may elapse before there is any definite evidence of its presence. Sometimes it is so slight that it can only be detected by the most careful investigation; at others it is so severe as to give rise to the suspicion of fracture or dislocation. Generally speaking, when it is due to bruising, or to what is still more common, effusion of blood into the tissues round the cord so as to compress it, the symptoms begin to diminish at the end of a few days. Recovery may then progress without interruption until it is complete, or it may be arrested at any point, leaving behind it greater or less impairment of power. Sensibility is frequently affected, too, but it rarely suffers in anything like the same degree. If it is lost completely the prognosis must be regarded as exceedingly grave, for it nearly always indicates that at some one point the cord has been crushed and disorganized. Sometimes a certain amount of hyperæsthesia or increased sensitiveness of skin may be detected over a small area immediately above the seat of injury, but the general tenderness all down the spine, which is such a common symptom in sprains of the back, whether they occur in railroad accidents or elsewhere, and the strange sensations, such as crawling, creeping, or tingling, experienced in the limbs, are probably due entirely to other causes. They are certainly met with in cases in which there is no reasonable ground for suspicion that the cord itself has been hurt in any way.

Into this part of the question, however, it is not my intention to enter at present. Injuries of the spinal cord, and the

consequences that may result from them, are matters m[illegible] too serious to be regarded merely as complications of spr[illegible] of the back, and the subject has been already exhaustiv[illegible] treated by Page in his work on "Injuries of the Spine a[illegible] Spinal Cord." My contention merely is that a very lar[illegible] number of the symptoms which are usually considered [illegible] definite proof that the spinal cord has been hurt may be, an[illegible] in a large proportion of instances probably are, due altogethe[illegible] to the injuries that the other structures in the back must sustain in such accidents.

Injury to the Muscles and Ligaments; Sprains.—S. C., thirty-two years of age, a strong, healthy man of exceptionally good physique, in getting out of a barge slipped and pitched head-foremost into the hold among some bales of goods. The shock was in a measure checked by his hands, or he would almost inevitably have broken his neck. As it was, he lay for some moments unable to extricate himself, with his head doubled under him and his chin driven down upon his chest. He did not lose consciousness; there was no concussion or other injury to his brain; there was no fracture or dislocation anywhere about his spine, though, owing to the severity of the shock he had sustained, he was unable to stand upright, and it was almost certain that his spinal cord had not suffered any very serious hurt, for after he had recovered from the shock he was able to move his arms and legs about freely in all directions. Sensation was not in the least impaired; there was no tingling or feeling of pins and needles; nor was there that peculiar sense of constriction round the body as if a string were tied round it, of which so many patients complain. The stress had fallen almost entirely on the muscles and ligaments at the back of the neck; these, no doubt, were severely strained, and it seems probable from what followed that the nerves running from the spinal cord had suffered in the same way.

The next day the shock had completely passed off. He had slept but little during the night, and he still felt giddy, everything seeming to go round when he attempted to sit upright; but he had recovered his natural color and expression, and the pulse and temperature were perfectly normal. He had completely lost, however, the power of moving his head or neck; the least attempt, especially nodding, brought on severe attacks of pain, shooting up over his head and behind

his ears on each side, so that he sat either with his chin resting on his hand, or with his thumbs behind his ears and his fingers grasping his face. Indeed, without support of some kind he seemed unable to hold his head upright. He complained of his back and neck feeling weak, as if he were going to be paralyzed, mistaking, as Hood has pointed out, the fear of movement due to the pain it causes for actual loss of power. The skin was exceedingly tender to the touch, as it is over every sprained joint, and there was a certain degree of swelling, very ill-defined in outline, over the part that had been most severely strained. What caused him most apprehension, however, was the difficulty that he felt in opening his mouth. He could shut it easily enough, but slight as is the muscular effort required to move it in the opposite direction, it was almost too much for him. The muscles which act from the upper part of the chest, and help to form a fixed point from which the lower jaw can work, were unable to do their fair share. They had not been injured themselves, but the nerves supplying them had been strained in the neck at the moment of the fall, and were unable to carry the necessary stimuli. For the same reason his breathing was very shallow and his speech slow and deliberate.

In a few days this began to pass away; the sense of strength returned, and movement became much more easy; but for a long time a peculiar sensation could be detected in the neck when the head was turned from side to side, as if two roughened surfaces were being rubbed against each other, or some dense fluid, such as extravasated blood, were being squeezed to and fro in the meshes of the cellular tissue. Gradually this, too, disappeared, but in spite of repeated blistering, the stiffness still persisted in the back of his neck. Improvement went on fairly rapidly up to a certain point, but then came to a standstill. Forcible manipulation, however, assisted by thorough kneading, soon effected a cure.

In this case the mischief was well defined, the ultimate recovery, though it was delayed for some time, was complete, and there was no inflammation or other complication. The cord itself was not injured, though just at first there was reasonable ground for suspicion; the whole of the symptoms were due to the damage the muscles and ligaments had sustained, and to the way in which the nerves were stretched.

In all probability, as Page has pointed out, many of the cases of what is sometimes called railway spine may be accounted for in this way. The symptoms, because they are serious and persistent, are referred to the spinal cord, instead of to the structures which surrounded and are especially intended to protect it.

Paralysis is one of these. Where this really exists there can be no question that the spinal cord, or the nerves at their exit from it, have sustained some exceedingly grave hurt. It may be that curious, almost indefinable, effect known, for want of a better term, as shock to the nervous system; or it may be actual bruising and laceration; something of the kind there must be, and in such a case it is necessary to exercise the most extreme precaution in the question of prognosis. But it often happens that, without the least intention of deceiving, patients describe themselves as paralyzed, or unable to perform some particular action, when, as a matter of fact, the attempt is merely prevented by pain, or, what is still more singular, by the belief that they cannot. Hood has pointed out how patients often describe a joint as feeling weak, speaking of it as if it were in need of some mechanical support, when the real cause is the dread of calling into action muscles that are stiffened from disuse or rheumatism. So it is with the spine; after a severe strain there is a certain amount of difficulty about calling the muscles into play, just as there is when they are affected by lumbago, and the patient is naturally very apt to think that he has lost power over them, and is going to be paralyzed. This was the case in the instance that I have quoted above, and similar examples affecting different parts of the body, according to the seat of injury, are of exceedingly common occurrence.

Hyperæsthesia, again, or increased sensitiveness of the skin, is always regarded with great apprehension. In some particular cases, as I have mentioned already, it is true that it is a symptom of injury to the spinal cord; but in the great majority, especially in those in which it extends down the whole of the spinal column, it occurs for exactly the same reason that it does over any sprained ligament, or muscle, and means nothing more.

The crawling sensations, too, that are complained of in various parts of the body, the tingling, and pins and needles,

are still more ambiguous. Often they are due to causes of an entirely different nature, pressure or traction, for example, on some of the nerves, or some alteration in the amount of blood flowing through the part; they cannot, at least in the absence of other evidence, be regarded as proof that the spinal cord has suffered to the exclusion of everything else. Occasionally even more remarkable symptoms are met with. In one case under my own observation, where the patient sustained a very severe strain with some contusion in the lower part of the dorsal region, there were typical attacks of what are known as lightning pains, shooting round the body with great intensity, and then ceasing abruptly; yet there was no evidence at any time that the injury had involved the spinal cord itself.

In short, these symptoms, which are usually regarded as definite proof that the cord has been injured, so far as they prove anything, are rather suggestive of injury to the structures that lie round it and protect it. These must sustain the brunt of the violence in any accident; the cord itself is placed in the position of the greatest possible security, protected as far as it can be from any external hurt, so that in the vast majority of instances it (very fortunately) escapes. From its great importance, and from the disastrous results when it is injured, it has caused everything else to be overlooked and forgotten.

Injury to the Bones.—Of the frequency with which the bones are affected there can be little doubt. Injuries of the back, in the shape of blows or strains, have to account for a very large proportion of cases of disease of the spine; and, probably, if the history of the rest could be obtained, it would be found to be true of most of these. It is difficult, of course, to bring forward direct proof of this; but a certain amount of confirmation may be obtained from the locality in which this affection is most common. A blow may affect any part; but strains, in such a structure as the vertebral column, are always felt most severely where a rigid and a flexible segment are joined together—where, for example, the neck or the lumbar region joins the thorax, which, from the attachment of the ribs and for other reasons, is peculiarly stiff. At any rate, whether this is the explanation or not, it is a fact that disease of the spine is particularly common at these two spots.

Injury to the Smaller Joints.—Sometimes the strain falls

on the smaller joints between the vertebræ, though it must be admitted that it is rarely possible to find any direct evidence of their being hurt. There are so many of them; they lie so close to each other; and the amount of movement possessed by each is so slight that unless the injury is extremely localized its effect is spread too widely to strain any single one. It is not improbable, however, that they suffer more often than is generally suspected; only the injury, owing to the depth at which they lie, and the way in which they are covered in by muscles, is not correctly diagnosed. At least, evidence of past mischief is sometimes found post-mortem, long after all history is forgotten; and suppuration even has been known to occur, and to spread until it made its way into the spinal canal, and involved the cord itself.

Ligaments.—The structures, however, which bear the brunt of strains, are the bands of fibrous tissue, and the muscles on the back and on either side of the vertebral column. With regard to these, the part played by the former is entirely mechanical. Close under the surface there is a broad sheet of extraordinary strength, extending outward over the muscles, binding them down, and protecting them so far as it can from being overstretched. A little deeper it is much more delicate and vascular, forming sheaths for all the separate slips, and uniting them closely to each other. Deeper still it becomes strong again; but here the fibres are short and irregular in direction, running between the prominences with which the bones are covered, and acting the part of ligaments. This fibrous tissue cannot stretch. When the violence is so great that the muscles are overcome, or so sudden that they are caught unawares, it resists as long as it can; then it gives way, rarely at any one single spot; more often here and there, where it is attached to the bones, or becomes continuous with the muscles.

Muscles.—These, on the other hand, are the most active ligaments the back possesses. Not only do they move one bone upon another, but, within certain limits, they are the main agents by which the extent of the movement is regulated. When those limits are passed, and, as a rule, not till then, the purely passive fibrous bands are called into play.

The result of this is that, as a rule, in accidents of this kind, the muscles suffer to a very serious extent. Sometimes they

are overstretched, and lose their power of contracting again; or they are seized with cramp; or they are crushed together and bruised. Sometimes there is a great effusion of blood into their substance, so that they become swollen and painful; or the sheath of fascia which surrounds them is split open to such a degree that they are displaced entirely from their surroundings, and dislocated; or they are even torn in two or wrenched from their attachments.

Dislocation of Muscles.—Many of these injuries occur commonly in sprains of other joints, but one of them, dislocation, is, if not confined to the back, at least very rarely met with elsewhere. It is most common in the neck, for here the movements are very rapid and extensive, while the muscles are especially long and slender. The head is suddenly twisted round to look in some awkward direction; there is a sudden sharp stab of pain, often causing the patient to cry out; something appears to be caught, and the head is held fixed. In a minute or two, when the acute pain has subsided, it can generally be brought nearly straight again; but it requires considerable effort, and it cannot be turned so as to face in the opposite direction, or even kept straight for long. As soon as it is allowed to assume the position of least discomfort, it bends over once more to the affected side. Careful examination in these cases sometimes shows a tender spot on the contracted side, slightly too prominent. If this corresponds in position and direction to some muscular slips, and if, when the part is manipulated, the swelling disappears, and full and painless mobility is instantaneously restored, it can hardly be doubted that the symptoms were due to the dislocation of one of these, which has slipped back into its place again. In some cases an audible snap can be heard by the patient at the moment of reduction; and, in one under my own care, an incautious movement on the part of the patient, before repair was complete, reproduced the displacement.

I have known several instances in which, from the practically instantaneous character of the relief, it is almost certain that this had happened; but I must admit it is much more common for the swelling to disappear gradually and for voluntary power to return by slow degrees. Probably, in these instances, there is no real dislocation; the muscular fibres are either in a state of painful and spasmodic contraction, such as is

common in the leg after unusual exertion, or some of them have been torn and strained, so that movement is painful until the injury is repaired, and the extravasated blood absorbed again.

I have never met with any similar unmistakable dislocation in the loins, though, no doubt, from the description given by Callender, its occurrence is quite possible. The patient, he narrates, was carrying a heavy weight on his shoulders, when he suddenly slipped, and, in spite of all he could do, was swung round by the momentum. The pain for the moment was intense, and though it did not continue his back remained stiff, so that he could not move about with proper freedom. On examining the part there was one very tender spot in the muscles by the side of the spine, where a decided irregularity could be detected; this was diagnosed as a dislocation. The patient was instructed to repeat, so far as he could, the movements he went through as he fell; and while doing this firm pressure was made on the painful spot. The swelling disappeared at once; full power of movement was regained; and the sensation of stiffness completely vanished. The case was completed, and the diagnosis verified by a subsequent repetition of the accident.

Method of Reduction.—In any injury of this description, even if the presence of a dislocation is not certain, it is always worth while to carry out some simple manipulation such as that described above. Whatever may be the reason, whether it relaxes spasm, or whatever it does, it is a fact that almost immediate relief is sometimes gained by this, though the symptoms are not in the least characteristic. In one case under my own care there was no history of an accident at all. The patient was a young man, healthy enough himself, but of rheumatic and gouty parentage. He had been sitting incautiously in a draught when overheated, and got an attack of muscular rheumatism. Curiously enough, however, the pain was limited to one side, and almost to one spot; had he met with an accident, I should at once have suspected the existence of a strain. In spite of the history, however, I determined to try the effect of sudden vigorous contraction, and accordingly made him sit down on a low seat, with his feet firmly pressed against the wall in front, so that the pelvis should be securely fixed. The tender spot was carefully marked, and then it was explained to him that he must stoop forward as low as possible, and at

the word of command suddenly straighten himself up. One arm was placed under his chest to assist him in this, and the thumb of the other hand firmly pressed upon the tender spot. The patient carried his part out loyally, in spite of the pain, and was completely and thoroughly cured at the second attempt. Some pain and stiffness returned in the course of the next day, but determined extension and contraction of the muscles involved, relieved him without further assistance.

It is very important in accidents of this kind to get a perfectly accurate account of the way in which it happened, and the smallest details often prove of great importance. The chief difficulty is to determine whether the seat of injury is one of the smaller joints, or a muscular slip by the side of it. Sometimes a soft and rather indefinite swelling can be made out beneath the skin; more often there is merely a certain amount of local tenderness, with a sensation of stiffness, or of inability to execute some particular movement, amounting in some cases, as has been already mentioned, even to a suspicion of paralysis in the patient's mind. Bruising is rarely seen, owing to the depth at which the injured part lies.

If the situation corresponds fairly well with the position and direction of some slender slip of muscle, the assistance of the patient must be called in, and what is required of him thoroughly explained. There are two chief ways in which the reduction may be effected; sometimes one succeeds, sometimes the other. In the first the patient is placed in an attitude that relaxes the injured part as much as possible, and then, while the hand or finger is firmly pressed upon it, is made to bring it suddenly and vigorously into action. In the second, which is rather the better—for it is very difficult at once, and when suffering pain, to move the back or neck quickly in any given direction at a moment's notice—the body is placed so that the dislocated slip is put upon the stretch, and held in that position by the operator, while the patient endeavors to straighten himself up against the resistance. The muscle suddenly contracts, alters its shape and consistence, and, from the relief that is experienced afterward, must, apparently, slip back again into its bed. Sometimes there is a sharp feeling of pain at the moment, and the preliminary stretching is always disagreeable, but the use of an anæsthetic is, of course, impossible.

Muscular Pain.—The most common trouble, however, after

sprains is something different to this, and is probably closely allied to muscular rheumatism. It may be the result of unusually severe, or of unusually prolonged effort; nothing is felt at the time, or for a few hours; then, generally speaking, at night a peculiar aching sensation begins to make itself felt. The skin is often tender to the touch, especially over the points that correspond to the exit through the fascia of the cutaneous nerves; but there is no heat or redness. The tissues show no sign of bruising; steady pressure, though it is unpleasant at first, gives relief rather than causes pain; and, except as a result of disturbed rest and sleep, there is no fever or constitutional disturbance. There is merely a constant wearing pain, with a sensation of stiffness and want of power, that renders rest for any length of time impossible, and entirely prevents the patient holding himself upright or moving about with freedom.

What may be the actual nature of the change in the tissues is uncertain in many of these cases. In some, no doubt, there is rupture, or straining of the muscular fibres, or there are minute hæmorrhages; but from the practical identity of the symptoms with those of myalgia, due to cold or gout, it seems probable that the cause is to be sought in the changed condition of the circulation, or of the nutrition of the part. During contraction of the muscles a much larger amount of blood flows through them than when they are at rest, and the blood-vessels are very much dilated. It is possible that when this is carried to excess by prolonged overwork it is succeeded by a condition of passive congestion, the vessels being overloaded, and the blood unable to circulate as freely or as rapidly as it should. Then the waste products accumulate and act as sources of irritation, and fresh material to replace that which is exhausted by fatigue is not supplied in sufficient quantity. Probably in those who are young and healthy this is not of material consequence; it merely causes a certain amount of muscular stiffness, which soon subsides when the part is rested and the natural equilibrium once more restored; but if any constitutional taint, such as gout or rheumatism, is present too, it seems to stamp the complaint with its own peculiar character, and makes it tenfold more severe.

The most common situation for this to occur is in the loins, owing to the large masses of muscle situated there, and to the

way in which they are called upon for unusual or sudden exertion in lifting heavy weights; but it may occur anywhere, even in the extremities. Wherever it is, care must be taken not to confound it with other disorders. It is not uncommon for affections, even of such distant parts as the viscera, to be attended by pain in various regions of the spine. To say nothing of examples which must occur to every one, I have known the back-pain of incipient small-pox treated as lumbago, and massage has before now been vigorously applied to a case of stone in the kidney.

General Treatment.—In the milder cases merely local treatment may suffice, but it is so common for an outbreak of some complaint (the existence of which may hitherto not have been suspected) to follow strains, that practically in all general treatment adapted to the particular constitution of each patient is essential. Just as an injury to the foot is often the apparent cause of the first attack of gout, so many of the muscular strains of the back owe at any rate their persistent character to the presence of some similar complication. It is for this reason that careful attention to diet is so necessary; and that such drugs as colchicum, iodide of potash, chloride of ammonia, the carbonates of the alkalies, and others prove so useful. Only it rarely happens that any indication as to which of these internal remedies is likely to prove most beneficial can be derived from the condition of the back itself. This is only to be ascertained by carefully inquiring into the previous history of the patient, and thoroughly investigating the other symptoms that are present. In other words, local measures should be employed to relieve the pain and stiffness, and to restore the condition of the muscles as soon as possible; but it must not be forgotten that the general state of the patient in most instances needs quite as much attention.

Local Measures. Warmth.—Warmth, either applied to the part itself, or generally over the whole surface of the body, is of excellent service in relieving the consequences of strains. The simplest plan is to wring a piece of flannel out of water as hot as can be borne, or to roast it in front of a fire, and press it firmly upon the affected area, renewing it from time to time as it cools. The skin becomes red; more blood circulates through it, and probably a considerable amount is diverted from the deeper parts; the congestion is relieved for the time

being; the waste products are carried away; more nutriti material is supplied, and the stiffness certainly diminishes. C bags of hot sand, or salt, may be used; they retain the he considerably longer, and from the way in which they can b fitted into any irregularity of surface, are particularly suite to certain parts of the body. If this is not convenient, th electric brush may be tried, passing it regularly all over th surface of the skin after it has been thoroughly dried first t increase the resistance. It is probable that the benefit derive from this is due almost entirely to the influence it possesse on the blood-vessels, and not in any way to the chemical effect of the current.

Baths.—Hot-water or vapor baths are almost too wel known to require mention. Turkish ones also enjoy a great reputation, especially for recent cases, and among those who are accustomed to them. For others, they must be recommended with a certain amount of caution, and the subsequent treatment in any case requires much more attention than it usually receives. At Aix, when the full effect is desired, the patient, after his bath, is quickly dried, wrapped in blankets, and carried in a sedan chair to his hotel. As soon as he reaches his apartment he is lifted into bed, still swathed like a mummy, covered up with additional blankets and a quilt, and left to perspire for a longer or shorter period. After twenty minutes or half an hour he is carefully rubbed down by an attendant who had accompanied him from the bath. Where this is impracticable, the patient should at least be very careful not to hurry away, but to remain two or three hours if necessary, and above all, to make sure that he is properly covered up.

When the complaint has already lasted some time, douche baths may be employed, conjointly with vapor baths. The patient should be seated on a wooden stool, with the feet immersed in warm water so as to avoid chill, and then jets may be directed against his back in any required direction. The size of the jet must be regulated by the amount of pressure, and by the temperature of the water; but it is rarely advisable for it to be more than a quarter of an inch in diameter, and it is always best to begin with warm water, and gradually replace it by cold. The effect is greatly enhanced by massage afterward.

Those who have never tried these baths, or who suffer

either from giddiness and a feeling of fullness in the head, or from a sensation of faintness after their use, may be recommended to take local ones with perfect safety. If the patient is in bed, a cradle may be placed over the body so as to leave a space round him, beneath the bedclothes, and the steam of a kettle introduced by means of properly-arranged tubing, until the desired effect is produced, taking care not to scald the patient's legs. Where he can sit on a chair, it is more convenient to arrange a mackintosh, or, if this is not available, a blanket, round his neck, so as to reach the floor on all sides, and then to place under the seat of a chair a spirit lamp with some boiling water. Both these methods insure copious perspiration within a very few minutes, and possess the great advantage of not affecting the patient's head or interfering with his respiration. Further, there is less risk of catching cold afterward, and aggravating or reproducing the original trouble; if the bath is taken of an evening, the patient can be placed in bed at once, and nearly always can make sure of some hours' refreshing sleep.

At Aix-les-Bains, according to Dr. Stewart, the method is still more highly elaborated. When the patient is sent to have a steam bath (the Berthollet, as it is termed), he is directed to an apartment which contains a curious wooden box, with a round hole in the movable lid. After undressing, he steps into the box, and finds that he is shut in all but the head, the round hole being occupied by his neck. Immediately a valve on the level of the floor is opened, the hot vapor rises about him, and he soon begins to perspire freely. The perspiration running down his brow trickles from his face. Presently he feels the streams flow down his sides and legs, and very speedily a feeling of oppression and debility comes on. After ten or twenty minutes the bath is opened up, the patient carefully dried, and removed to his hotel.

Hot-water baths act in the same way. The beneficial effect they exercise is almost entirely due to their temperature, and proportionate, within limits, to the length of application. The salts that they contain, whether neutral, alkaline, or sulphuretted, are of very little consequence. If they exist in certain degrees of concentration, they stimulate the cutaneous circulation, but that is all. For this reason peat or mud baths are, as a rule, more efficacious. The one feature common to

all bathing establishments which enjoy a high repute is the temperature of the water, and probably the benefit derived from the use of the baths (as distinguished from a sojourn at the place) is due entirely to this.

Friction.—Friction, either with the hand or with a flesh brush, is very grateful in these cases. The direction should be upward, toward the head, and the strokes light and rapid. The effect is, to a certain extent, the same as that of heat; there is a temporary contraction of the vessels near the surface, followed by a more lasting dilatation and more rapid circulation of the blood. It possesses, however, in addition, considerable influence on the nerves of sensation, and it is not improbable that it is felt even more widely than this would imply. At least, it is difficult to explain on other grounds the undoubted power which steady friction along the back seems to possess in allaying some forms of nervous excitement and inducing sleep.

Liniments.—Stimulating liniments, containing camphor, ammonia, or turpentine, may be usefully employed in conjunction with either friction or heat. Sprinkling a few drops of turpentine on the heated flannel before applying it is generally sufficient, or some of the liniment may be rubbed in with the hand. This acts as a mild form of counter-irritant, probably temporarily withdrawing the blood from the deeper parts toward the surface, and where the stiffness and pain have lasted some time this is more effectual than either heat or friction by itself. If the tenderness is limited to one or two spots, and especially if these correspond to the places where the nerves perforate the fascia, blistering fluid, painted on once or twice, according to the thickness of the skin, answers better still.

In rare and exceptional cases more powerful applications, even the actual cautery, may be used. How these act is not clear; they may merely withdraw blood from the deeper parts or they may act in some way through the nervous system; for there is little doubt that certain organs are always in definite nervous relation with certain parts of the surface of the body, and are affected when these are in any way stimulated. However this may be, there is no question that sometimes this agent may be employed in relieving deep-seated pain, especially about the bones, with conspicuous success.

When the skin feels sore and tender after a sprain, the essential or aromatic oils often give very great relief. Many of the quack remedies employed to soothe pain, even the deep-seated pain of acute gout, owe what merit they possess almost entirely to these. A very favorite application in Germany, known as Hoffmann's balsam of life, consists of an alcoholic solution of balsam of Peru and seven of these aromatic oils mingled together. They may be either painted on the skin, and left exposed, or dissolved in spirit in various proportions, and covered over with oiled silk to prevent too rapid evaporation. Menthol is one of the most convenient, and acts especially well when mixed with camphor or croton-chloral, so as to form a thick oily liquid. Probably in this instance, too, the relief is in no small measure due to the effect produced upon the cutaneous nerves.

In certain cases minute quantities of morphia, belladonna, or veratria may be combined with these. It must, however, be remembered that if chloroform is used as a solvent, a considerable amount is absorbed through the skin, particularly if friction is used at the same time, and that in spite of the comparative thickness of the cutaneous covering of the back and the paucity of sebaceous glands. Belladonna plasters, which are strongly recommended by some, not only share with all other plasters the objection of being intolerably dirty, but have the additional disadvantage of sometimes causing an acute attack of eczema. Quite as great benefit may be derived by wearing a belt of flannel or, if this is too irritating, one of silk next the skin.

The hypodermic injection of anodynes, such as morphia, may occasionally be necessary, but it is always as well to postpone this until all other remedies have been exhausted. The very ease with which it gets rid of the pain is its greatest danger. It rarely cures the complaint, though it gives a temporary sensation of comfort, and is only too likely to be required again before many hours are past.

Ironing.—Besides these there are other remedies which are especially suited to deep-seated and large muscular masses, such as exist on either side of the spine in the loins. Ironing has already been alluded to. The patient should lie in bed, rather on his face, with the body supported by pillows in as comfortable a position as possible, and should turn from side

to side as occasion requires. A well-warmed piece of flannel (great stress is laid by some on its being unwashed) is then stretched over the affected part, and the muscles on either side of the backbone thoroughly ironed in all directions with an iron as hot as can conveniently be borne, using considerable pressure at the same time. The best for this purpose are those of rather small size, with the edges and angles well rounded off, so that they may be pressed into all the depressions between the bones without causing pain.

Acupuncture.—Acupuncture, again, though it is rarely employed nowadays, and seems, like bleeding, to have gone out of fashion, is at times very efficient in removing chronic muscular pain. How it acts is not thoroughly explained. Ordinary long darning needles answer very well. They are simply thrust through the skin, deep into the muscles, and withdrawn again after a few minutes. If the plan is successful they leave behind a bright red areola, which varies considerably in size and duration in different cases, and probably is dependent on the condition of the nerves that are stimulated. The pain is exceedingly slight, especially if the thrusts are made firmly and rapidly, and the punctures scarcely bleed.

Galvanism.—Galvanism, too, is very successful in treating muscular stiffness. The skin should be well sponged over first with warm salt and water, so as to avoid irritation as much as possible, and either the labile or the stabile plan adopted. The latter is the best to commence with, and then, after the current has been passing some time, the direction may be reversed once or twice. The electrode applied over the muscle should be of large size (a zinc plate covered over with leather, well moistened, answers as well as anything, as it may be cut or bent to any shape), and the current used of proportionate strength. Then, before leaving off, a smaller electrode may be substituted, and passed over the whole of the surface with a weaker current (if possible in an ascending direction) so as to secure its refreshing action and remove any sensation of fatigue. The sittings should not last longer than five or ten minutes, and it will generally be found that every other day is sufficient, especially if kneading or ironing is used on the alternate ones.

Massage.—Massage, if it is thoroughly carried out, is more successful still. Its action is most refreshing and invigorating.

Under its influence the aching and stiffness disappear, the blood circulates more freely through the muscles, the waste products are carried away, nutrition improves, and strength and voluntary power begin to return at once. It seems to possess the same restorative influence over the deeper structures that friction has upon the skin.

Percussion and kneading are both recommended. The former is the easier, and does not require so much skill or experience; but it only affects superficial parts, and is altogether of more limited application. The ulnar side of the hand may be used, or an instrument which bears a general resemblance to a hammer, with a stem of whalebone to secure elasticity, and a head faced with India-rubber. With this, held rather lightly, the whole of the stiff and painful part of the back is thoroughly percussed, the number of strokes rising to as many as three or four hundred in the minute, until the skin begins to glow.

Kneading is of much greater service, but requires practice before the full benefit can be obtained. The object is to compress and relax alternately the deeper-lying muscles, and to squeeze their contents onward, so as to insure a more rapid flow of blood and plasma through their substance. Consequently the movement must be regular, definite in direction, and well ordered.

A muscle at rest receives an exceedingly small quantity of blood, compared to what flows through it when it is contracting. So long as it is doing no work, the plasma which pours through the walls of the vessels into the interspaces round remains almost stagnant; the fibres are very slow in getting rid of their waste and in receiving a fresh supply. As soon as the muscle begins to act, the vessels dilate, the current of blood is quickened, the plasma is driven on at a much faster rate, and the nutrition improves beyond all measure This is helped to no slight extent by the alteration in the shape of the muscles. These are all incased in a comparatively unyielding fibrous sheath, differing in strength and density in different places. The plasma collects underneath this, filling up all the clefts and spaces left between the fibres. Each time the muscle contracts it compresses some of these, and causes others to dilate, so that it alternately sucks and drives the fluid plasma on. And, as a matter of fact, it is well known that the flow

of plasma, as well as that of blood, through the substance of a muscle, increases immensely as soon as it begins to work.

Massage aims at imitating this. Its object is, by the rolling and kneading of the muscles, to increase the flow of blood and plasma through them, get rid of the accumulated waste, and stimulate nutrition by supplying fresh material in larger quantity. If carried out thoroughly it is almost certain to give relief, but it is not a thing to be undertaken rashly, without previous training, and without some knowledge of anatomy. Massage and rubbing are not synonymous terms.

Supposing the lumbar region to be affected, the patient must be placed upon a couch of convenient height—as already described in speaking of ironing—and well supported from underneath by cushions, so that the muscles of the loin may stand out beneath the skin without being contracted. The operator should stand over him, at a suitable distance, so that his movements are not cramped; and then, with both hands, moving one after the other, knead and squeeze the muscles, first on one side and then on the other, rolling them, as it were, away from the middle line, and pressing them onward and upward toward the head. The whole hand must be used, the fingers, as it were, being insinuated, as far as possible, under and between the groups of muscle, the skin being allowed to glide, to a certain extent, over the structures beneath. Then, if there is any very painful spot left, the muscles may be grasped with the hands and firmly kneaded with the thumbs, moving them round and round in small circles intersecting each other over it so as to knead and squeeze the structures round it from all sides.

The pressure should be gentle at first, and then gradually become firmer and firmer. No liniment or oily substance can be used, as it weakens the grasp of the hands and tends to defeat the object of the manipulation. If it is desired it may be rubbed in afterward. The rate of movement must vary with the thickness and depth of the tissues to be manipulated, and with the amount of pressure used. Within reasonable limits, the slower the better. There is a great tendency on the part of many, who are supposed to practice massage, to use much too much force, and to make all the movements too rapid. Five minutes, as a rule, is sufficient for a sitting, though it is often beneficial to apply an ascending constant

current to the muscles for a minute or two more afterward. It answers better to repeat the manipulation later on in the day than to continue too long at one time. The golden rule is never to fatigue the patient, or to produce the least degree of tenderness or bruising. Those who have not had much experience or a thorough training are very apt to overdo it.

CHAPTER XIII.

INTERNAL DERANGEMENT OF THE KNEE.

THE knee joint is occasionally the seat of a peculiar kind of accident, which, for want of a better name, was called internal derangement by Hey, who first described it. It is extremely painful; it occurs during perfect health from most trivial causes; if it happens once it is always liable to occur again; and after a time the joint is very likely to become seriously crippled. Yet, mainly owing to the fact that opportunities of examining the interior of the joint are seldom met with, its pathology is almost as much a matter of discussion as ever it was.

It is undoubtedly connected with two flattened structures in the joint known as the semilunar cartilages. Roughly speaking, they form two circles, lying side by side between the bones. The margin of each is the thickest part; from this they slope off gradually toward the centre, where there is a perforation. The circumference, especially that of the internal one, is attached to the bone more or less firmly all round; but the part corresponding to the centre of the joint, where the two cartilages touch each other, is much the most secure. At this point each of them is interrupted for a short distance, and the four ends so formed are firmly united to the bone beneath. The outer cartilage forms nearly a complete circle, so that its ends lie close together; the inner, on the other hand, barely forms two-thirds of one. This peculiarity of shape, and the presence of several accessory bands, tend to make the inner of the two the more secure. It scarcely moves at all in ordinary actions of the joint, merely, when the weight falls on it, expanding a little in all directions from its centre. The outer one, on the other hand, glides backward and forward freely.

It is generally supposed that in a typical case of internal derangement one or the other of these cartilages slips from its position and is caught between the bones. As a conse-

quence the movement of the joint is abruptly checked; complete extension becomes impossible; the two bones are forcibly wedged apart from each other, and the ligaments that hold them together are stretched and strained. The internal, in spite of its greater security, suffers more often; the external, perhaps from the very way in which it can accommodate itself, nearly always escapes.

Rupture of the Semilunar Cartilages.—Sometimes they are torn completely away from their attachments. Godlee mentions one instance in which the external was found rolled up toward the centre of the joint, having been separated from the bone all around the margin. Annandale has described the anterior end of the internal one, stretched or wrenched away from the bone; and probably they may be injured in other ways as well, torn across, for example, or twisted round in various fashions, or, if the violence is sufficiently severe, forced out from the joint altogether until they project beneath the skin. Then there is, generally speaking, laceration of the lateral or of the internal ligaments of the joint as well, so that the bones are dislocated from each other.

If the joint is the seat of chronic synovitis, or is subject to attacks of rheumatic gout, or if, in younger people, there is that peculiar loosened condition of the ligaments which I have already described, the displacement may be much more complicated. It is not unusual to find in these circumstances that the cartilages may be made to slip backward and forward between the bones by the mere pressure of the finger. It is not fair, however, to regard these as genuine examples of internal derangement. In this, the joint is, to all appearance, perfectly sound and healthy; the violence is exceedingly slight; and the relief is instantaneous. There may be a transient effusion into the cavity of the joint after the displacement has taken place, but clearly there can be no tearing or even severe bruising of any of the internal structures. The greatest injury must fall short of this, or the time required for repair would naturally be much longer.

Displacement Without Rupture.—The best description is given by Knott, of Dublin, who has suffered from it himself on repeated occasions. It first occurred to him when he was a boy, as he was walking quietly along. All of a sudden, without having sustained any wrench or twist of which he was

conscious, he was seized with such agonizing pain on the inner side of the knee joint that he half fell, half sat down, on the ground, sick and faint, with a sensation of utter helplessness. The knee was slightly flexed; he could not move it one way or the other, and voluntary power over it was entirely lost. Instinctively he applied his hands one on either side of the joint, and made as powerful a pressure as he could in the hope of relieving the suffering. This caused the flexion to diminish; when suddenly the pain again became almost intolerable, a clicking sensation was conveyed to his hand and his ear at the same time, and perfect relief came at once. He managed to walk away, and no after trouble of any kind followed.

After that the accident happened to him on many occasions; he noticed that it never occurred during active movement, but only when the muscles were off their guard; and that if the knee-joint was slightly bent, the least force applied so as to turn the toes outward was sufficient to cause it. So long as he walked with the toes turned in the joint felt secure; the reverse of this is the case when the displacement concerns the external of the two cartilages.

From this he is convinced that, at least in his own case, the displacement consists in the posterior part of the internal cartilage gliding forward from its position until it is caught between the bones. This forces them apart, like a wedge, and completely stops the movement of the joint. The muscles round contract at once, and become perfectly rigid, so that voluntary action is out of the question for the time. Afterward, when they are tired out, and the joint fills with fluid, the power of movement returns again; but complete extension is not possible so long as the displacement lasts.

Hey's account is closely similar. He describes the knee as being not unfrequently affected with an internal derangement of its component parts, as a consequence of trifling accidents, and states that the trouble is now and then removed as suddenly as it is produced, by the natural movement of the joint, without surgical assistance of any kind; but that it may remain for weeks or months, and then become a serious misfortune, as it causes a considerable degree of lameness.

"The disorder may happen with or without contusion. In the former the symptoms are equivocal, until the effects of the contusion are removed. When no contusion has happened,

or when the effects of it are removed, the joint, with respect to its shape, appears uninjured. If there is any difference from its usual appearance, it is that the ligament of the patella appears more relaxed than in the sound limb. The leg is readily bent and extended by the hands of the surgeon, and without pain to the patient. At most, the degee of uneasiness caused by this flexion or extension is trifling, but the patient himself cannot freely bend or extend the limb in walking; he is compelled to walk with an invariable and small degree of flexion; yet in sitting down the affected joint will move like the other."

Bonnet, from experiments on the dead subject, confirms Knott's views of what takes place in these cases, and shows clearly that it is produced by twisting the leg outward when the limb is slightly flexed. Certainly there is no laceration or extensive displacement of any internal structure. Sir Astley Cooper wrote of it in much the same terms, stating that it may be produced by striking the inner side of the great toe against any slight projection, when the knee is bent as in walking. I have seen the same thing myself on several occasions, but the most interesting example with which I am acquainted was told me by a medical man of himself. During his student days, while playing at football, he suddenly made a violent kick, missed his aim, and fell down, feeling very sick, with intense pain on the inner side of his knee. He was entirely unable to move the joint, but after a friend had slowly flexed the limb as much as he could, and then rapidly extended it, the pain disappeared all of a sudden, and he could walk as before; only for some days there was a considerable amount of swelling, and a sense of insecurity about the joint. The same thing happened to him on several occasions afterward.

These symptoms agree so closely with those described by Hey, Knott, and Bonnet, that there can be no doubt the actual derangement is the same, though the way in which it is produced is apparently altogether different. I say apparently, because, if the action of the knee joint under these conditions is considered for a moment, the difference completely disappears. When the leg is extended, just as it comes to lie in the same straight line with the thigh, a slight amount of rotation outward takes place at the knee joint, so that the ligaments become tense, and the joint sufficiently secure to bear the

weight of the body in walking. In this particular instance extension was extremely rapid and vigorous; there was no weight resting on the limb to keep the bones in apposition, and, consequently, there was nothing to check the rotation outward. This allowed the posterior margin of the internal cartilage to be carried forward until it was caught and fixed by the spasmodic contraction of the muscles. Voluntary movement at once became out of the question. I have since been told that accidents of a similar character, only not sufficiently severe to cause any actual displacement, are not uncommon at football; there is merely a sickening pain on the inner side of the joint for a few minutes, and in some instances a slight amount of effusion afterward; but the displacement is not carried far enough for the cartilage to be caught and fixed.

Reduction.—The method of reduction has been already mentioned; nothing is easier when once it is understood, especially if the patient is under an anæsthetic. Hey recommended making him sit on a high chair, facing the surgeon, who should grasp the limb firmly, extend it until it was as straight as the circumstances would allow, and then rapidly flex it again. Later surgeons have reversed this proceeding with some advantages, as preliminary extension is much more painful than flexion, and in the second step rapid flexion is somewhat difficult to carry out. Whichever way is adopted, while it is being done firm pressure must be made with the thumb of the disengaged hand over the position of the displaced cartilage. As soon as free movement is restored the limb is carefully padded with cotton wool, and thoroughly bandaged to prevent any accidental redisplacement, and to limit the effusion that is almost certain to follow

After Treatment.—This apparently trivial precaution should never be omitted. The chief danger of this singular accident is its extraordinary liability to occur again and again. If the effusion is not checked at once the capsule and the ligaments yield until the natural tension of the joint is lost, and the displacement becomes easier than ever. When once a commencement has been made these two things act and react continually on each other; each displacement causes a fresh amount of effusion; each time the effusion occurs it makes the displacement more easy. At length it often happens that

the distention becomes chronic and that the joint is seriously disabled, though it must be admitted that when this has happened the displacement does not cause so much pain as it did.

After the effusion has been absorbed it is always advisable to wear a retentive apparatus for some months, especially when indulging in any exertion which, like lawn-tennis, has a particular tendency to produce this derangement. If it has only happened once, an elastic knee-cap, strengthened and padded opposite the internal cartilage, may suffice; but care must be taken with an appliance of this description that more harm than good does not result. It must never be worn at night; and when it is taken off the knee should be thoroughly rubbed and kneaded to restore the circulation through it, or else the tissues waste away and the elastic becomes so comfortable that it is regarded by the patient as indispensable.

If one of the attachments of the cartilage has been torn, so that there is a definite displacement recognized by the projection it forms beneath the skin, on the outer or the inner side of the joint, this is not sufficient. Either a mechanical contrivance must be worn for the purpose of checking irregular movements of the leg when the lateral ligaments are slightly relaxed, or else, as Annandale has done on several occasions, with conspicuous success, the joint must be opened, and the offending cartilage stitched into position.

A very good arrangement for cases of this kind consists of two well-padded metal plates accurately fitted round the knee-cap, one on either side and held together above and below by short straps. These plates are connected together by a steel spring passing horizontally across behind the joint, so that when the splint is in position they press firmly on the unprotected portion of the capsule, where the displacement is most likely to occur. If this does not answer, or if it is thought, from an examination of the case, that the derangement in the case of the internal cartilage is really due rather to outward rotation of the leg while the ligaments are relaxed, the best kind of apparatus is formed on the principle of two lateral bars jointed opposite the knee, and connected together above and below by a circle round the limb, formed partly of metal and partly of leather. An additional strap across the joint above and below the patella is sometimes of service. This is

heavier and more cumbersome, but much more efficient t the former in checking irregular movements of rotatio either direction. Flexion and extension are not in the l impeded, and after the patient has once grown accustome it even lawn-tennis is possible in it.

CHAPTER XIV.

CONTRACTION OF THE FINGERS.

It sometimes happens that sprains, instead of running an ordinary course, are liable to be followed by unusual results, due either to some peculiarities of structure in the part itself, or to the presence of an overpowering constitutional taint, or to the influence of both together. One of these, which occurs in the hand, tying down the fingers, and giving rise to serious inconvenience from the way in which it interferes with their movements, is known as Dupuytren's contraction.

Structure.—The whole of the palm of the hand is invested by a sheet of dense fibrous tissue, which forms a sheath round all the muscles, and is closely united to the skin on one surface and the bones on the other. In the centre it is exceedingly strong, stretching over the tendons and retaining them securely in all the movements which the hand executes. It is to this, in great measure, that the palm owes its firm resisting feel. At the sides, where it is continued over the muscles of the thumb and little finger, the thickness is not so great; but where these portions join the central part there are two strong partitions passing deeply toward the back of the hand, and sending off side branches in a direction parallel to the surface between the deeper structures. At the clefts of the fingers the central part breaks up into four divisions, each of which again divides, so as to form bands running down the sides until they become attached to the bones and the sheaths of the tendons. Where the division takes place, and the several portions commence to diverge, another layer, lying deeper than the tendons, comes to reinforce it from below, and just here it is very closely attached to the skin. Sometimes, as a result of strains, this fibrous tissue slowly but almost irresistibly contracts, until the ring and little fingers, and sometimes even the middle one, are rigidly flexed into the palm of

the hand so that no reasonable amount of force can straighten them again.

The first thing to attract attention is the presence of a small hard nodule in the palm of the hand, at a point corresponding to the lowest of the transverse creases into which the skin is thrown, and to the interval between the ring and little fingers. It is not painful unless pressed upon or roughly handled, and does not at first give rise to any inconvenience; there is merely a hardened inelastic spot, where the tissues are bound together so that they do not yield and give way to each other in every movement as they ought. Soon, however, the skin begins to waste and lose its flexibility; the fat disappears, and it becomes tied down to the fascia beneath so firmly that it is practically incorporated with it. Then prolongations may be noticed running from this point upward toward the wrist, and downward to the fingers. The latter are much the stronger, and if the process continues, the ring and little fingers become more and more flexed by the contraction of these bands until they are held down immovably in the palm. One of these two fingers is generally the first; but often both of them suffer, and sometimes the middle and even the index are affected as well. When the bending is complete, the finger catches in everything like a hook, so that it is liable to be pulled back and hurt at any moment, and becomes the source of extreme annoyance from the way in which it interferes with every action, even such apparently trivial matters as shaking hands.

Cause.—Dupuytren was the first to point out the cause of this deformity, and it has ever since been known by his name. He showed that the flexion and subsequent rigidity were due entirely to the contraction of the fascia by the side of the fingers, and that the tendons themselves took no share of any kind in its production. They are and remain perfectly free. It is not, however, quite so simple a process as it appears to be from this; the shortening does not take place merely in one direction. If the part is carefully examined, the first thing that is noticed is a depression of the skin where it is tied down to the tissues beneath. The shrinking is general; the fibrous tissue contracts in all directions, and the change is made more conspicuous still by the absorption of the fat, and the wasting of the soft parts as the blood-vessels become more and more constricted.

It is this which renders the difficulty of effective treatment so great. If the contraction merely took place in one direction, simple division of the shortened band would be sufficient. Unhappily this is rarely the case. The whole of the fibrous tissue of the palm at the affected spot becomes so dense and rigid that such a proceeding scarcely produces any effect. The contraction is as great in depth as it is in length. The fat is absorbed; the muscle wasted; the skin loses it suppleness and flexibility, and the texture is so changed that in advanced cases the whole of the tissue between it and the bones beneath appears to be converted into a dense fibrous mass, which creaks and grates under the knife when an attempt is made to divide it.

Much of the interest that is always expressed about this deformity arises from its supposed connection with gout. It is believed by many that this alone, without injury of any kind, is sufficient to produce it. It is certainly true that it is much more common among men than women, and that many more cases are met with in private practice where gout is frequent than among hospital patients; but it hardly seems probable that this can be the only cause.

If this is the case, it is not a little singular that a Frenchman should have been the first to give a true account of its pathology; and even if the presence of this complaint is admitted as one of the reasons for the obstinate persistence of this contraction, it hardly seems probable that it can be the sole cause of its commencement. In a certain proportion of cases it is impossible to obtain any history of gout, either in the patients themselves, or even in their families; and though it is more commonly met with, it is true, after middle life, it certainly does occur long before. I have seen it as early as one-and-twenty, and one of the worst cases that has ever come under my notice (it was so bad that one of the fingers was amputated) was in a man only four years older.

Urate of soda, too, is rarely found in connection with this, unless there is a general deposit in other parts of the body; and, so far as I know, this form of contraction has never been described in connection with the feet, though it is notorious gout has a special predilection for this region, and there is a layer of fascia in them almost identical in structure and arrangement with that of the palm of the hand. The immediate

cause is either a single, sudden strain, bending the fingers back, or long-continued irritation, such as that produced by the constant pressure of a round-headed stick in the palm of the hand, especially during convalescence from illness. Gout very probably is one of the conditions that predispose to its occurrence, but it is almost certain that it is not the only one.

It is more common among the upper and middle classes (or, perhaps, it would be more correct to say that they more commonly apply for relief) than among laborers, because in these the hands are thoroughly hardened and trained to work of all kinds, and a strain that would cause serious injury in the one is hardly felt by the other. It does, however, occur among out-patients, especially among those who are employed in engineers' shops; I have seen many such cases, and have been assured by the men that quite half of their number are affected more or less, only they do not consider it worth while applying for relief. With regard to this it is significant that, among the class of people who furnish the majority of the out-patients in a general hospital, it is almost as common among women as it is among men.

The comparative weakness of the fingers on the inner side of the hand is sufficient to account for the fact that they are affected almost exclusively. The muscles attached to them are so much weaker that they are unable to stand a strain that is at all sudden or severe, and give way before a force the others can bear with ease.

It is the obstinate and progressive character of this contraction that renders it so serious. When once it has commenced, though it may remain quiescent for long periods, it has on the whole a decided tendency to grow worse and worse. In the earlier stages it may be relieved, or even cured, without great difficulty; in the later ones this is impossible without operation, and sometimes this condition becomes so bad that the patient prefers the permanent and distressing deformity of losing his finger.

Treatment.—Before contraction has made its appearance, when there is only a small hard nodule to be felt beneath the skin, the very simple device of repeatedly working the part with the thumb of the other hand, while the fingers support the back, is often sufficient to arrest its progress, only it must be carried out regularly and systematically. Rotatory motion,

with the affected finger well stretched out, so as to make the contraction tense, is the most useful, changing the direction now and then, and keeping up firm pressure all the while. If this is carefully carried out every day, or better still two or three times a day, and if at the same time further flexion is checked by constantly straightening out the fingers and the palm, pressing them spread out upon a table or other firm object, the tendency can certainly be kept in check for years. Too often, however, this precaution is so simple that it is neglected, and when advice is sought the contraction is already well marked and the skin firmly adherent.

Even then much may be accomplished by the same means, supplemented by the use at night of an appliance devised to exercise a certain amount of continuous traction. In the later stages, and after operations, some contrivance of this description is essential. When the deformity is only slight, I have found an ordinary wooden splint, firmly padded opposite the knuckles, very useful. It must be well fastened by means of straps and buckles to the wrist and the two first fingers; and little caps made of some soft metal, such as thin sheet lead, fitted on to the under surface between the affected joints. Steady continuous traction can then be made on these at night by means of elastic bands; and, if the angle is still more than a right angle, a great amount of improvement can generally be effected in a comparatively short space of time.

Where the flexion is more advanced, or where an operation has been performed, so simple a contrivance is rarely sufficient. It is generally necessary to have an appliance constructed by an instrument-maker. The principle on which they work is essentially the same. There is a broad, well-padded metal plate fitted to the back of the hand, so as to be quite firm, and provided with extension racks lying over the fingers, and bent at an angle to suit the deformity. This is buckled on of an evening, and screwed up until the desired position is obtained.

The difficulty is to graduate the tension with sufficient nicety. On the one hand the continued use of the instrument becomes exceedingly irksome, unless a certain amount of improvement is visible; on the other, there is the pain due to the tension on the fibrous structures of the palm, and the fear of injury to the skin from pressure. It is a rough but fair rule, when no operation has been performed, to straighten out the

fingers each time as far as the patient will allow them; and then to relax again slightly. Progress must be slow, and, if the degree of pain is at all severe, the patient, as a rule, refuses to continue, and remains satisfied with a slight and temporary degree of improvement. Care must be taken as often as the splint is removed, and again before it is applied, to knead the tissues of the palm thoroughly, and to soak the hand in water as hot as can be borne; otherwise a great deal of the benefit that may be derived from the extension is almost certain to be lost.

An immense amount of improvement in the method of operating has been effected in recent years by the ingenuity of various orthopædic surgeons, and especially William Adams. Dupuytren himself merely made a transverse incision through the skin and fascia, at the most resisting point, so that when the finger was straightened out there was a lozenge-shaped wound, the sides of which might in successful cases grow together. This, however, rarely happened; the wound nearly always had to heal by granulating, and the resulting cicatrix possessed, as it always does under these conditions, so great a power of contraction that the deformity was reproduced often in a worse degree. I have seen a finger irretrievably tied down within a month by the cicatrization of a comparatively superficial wound along its under surface, not deep enough to involve either the tendon or its sheath.

This was improved upon first by Goyrand, who, before dividing the contracting band, made a longitudinal incision through the skin so as to improve the chance of primary union. In some cases (those, for example, in which the contraction is deep rather than broad, and does not involve more than one finger) this answers fairly well, especially as the means for securing early union are much better understood at the present day. The skin must be detached first on either side with the greatest care, and the band, besides being completely divided, must be separated as far as possible from its deep connections by incisions parallel to the surface. When so much as this is done, however, it is more satisfactory to isolate the whole of the contracted tissue from its surroundings, and remove it bodily. I have known this done on several occasions with the most excellent results. The most serious objection is that, when the adhesions are spread over any extent of surface, a

great deal of manipulation is required to detach the skin, and, consequently, there is some danger of impairing its power of recovery. If it does perish, the wound that is left is large, though superficial, and there is a great tendency to contraction, so that in cases where the lateral extent is considerable it is, as a rule, advisable to select another method.

For this reason, as soon as the merits of subcutaneous tenotomy became known, other methods were almost entirely superseded. At first the band was divided in one single spot, without much benefit resulting. Then a totally different plan was adopted, minute punctures, as many as may be required, being made wherever the contraction stood out prominently beneath the skin, recollecting that the shrinking is a general one, taking place equally in all directions. The number is not regarded as of any moment. The object is to divide the contraction thoroughly, wherever it resists, and to separate it from the parts beneath.

The palm of the hand is dealt with first, selecting those points where the skin is movable over the subjacent tissue; then each side of the affected fingers by itself. The skin wounds are scarcely visible; there is little or no bleeding, and if they are covered up at once, and firm pressure made with little pads of lint, they ought to be perfectly sound within three days. No attempt at extension must be made until they are.

Where the position of the fingers is such as to allow it, massage is of great assistance, both as a preliminary measure and in the after treatment of the case. It loosens the attachment of the skin, gets rid of the thickened epidermis, so that the wounds close more accurately, and does away, to a great extent, with the necessity of detaching it from its deep connection. But three clear days at least must be allowed to pass before the operation. There is always a certain amount of hyperæmia attendant on kneading and manipulation, and under these conditions this is not advisable.

After the punctures have healed, massage is of even greater service. There is no fear of their being reopened if sufficiently firm pressure is employed. The surface is fixed in this way, so that no tension can fall on them; while the lymph that fills up the interstices of the deep incisions is dispersed, and driven into the absorbents, so that the amount of fresh-formed cicatricial tissue, and the danger of recontraction, are both of them re-

duced to a minimum. It is not uncommon, where the operation has been thoroughly carried out, to find the hard nodules, left behind at first, becoming smaller and smaller, until they either disappear altogether or cease to give rise to any trouble.

Extension, by means of instruments, should be steadily employed, at first all day long, and then, according to the progress made, at night only. The same general rules must be observed as when no operation has been performed, not going too fast, for fear of reopening the punctures and injuring the skin, or too slow, for then the contracting bands will reform and reproduce the deformity. As a rule, it is advisable to make as much progress as possible during the early days, for then the tissues that unite the severed portions are still soft and yielding. If it is to be successful, the whole must be accomplished within three weeks, though the appliance must be worn for some time longer on account of the danger of recontraction.

CHAPTER XV.

MUSCULAR CONTRACTION.

In speaking of the results of sudden twists and sprains, it was mentioned that the muscles and tendons rarely escape altogether, and it was pointed out that sometimes, even when the joints are not concerned, they sustain very serious injuries from being crushed or bruised, and, perhaps, torn in two, in the effort they make to save the joint. This, however, is not all. Though there may be no visible effect at the time, it is not uncommon for changes in the nutrition or the activity of the muscles to make their appearance at a later period, and to become worse and worse as time goes on, until they interfere seriously with the use of the limb, and lead, perhaps, to very grave results.

These may be distinguished from those already described as secondary or remote. There is no fixed time for their occurrence. They may appear within the first few days, or three or four weeks, or even more may pass without any change being noticed, and their variety is almost unlimited. Some are probably the result of inflammation, as when groups of extensor muscles, to the complete exclusion of the rest, waste or atrophy shortly after the injury. Others appear to be dependent on some morbid condition of the nervous system. Many are the direct consequence of the accident, without which they would never have occurred; many more, like those complaints known as hysterical, are merely the local manifestation of a general condition, determined to one particular part by the occurrence of the accident. Some few are still only capable of a conjectural explanation.

Cramp.—In some instances the muscular contraction is of a very simple character, when, for example, after some sudden strain, a particular group, or set, becomes hard and tense, and passes almost at once into a state of spasmodic rigidity. It may last for the instant only, subsiding of itself, and merely

leaving the part stiff and tender for the next day; or if the tension is not relieved it may be kept up until exhaustion compels the fibres to relax. When this occurs, as, for example, in internal derangement of the knee, the joint is said to be locked. So far as the patient himself is concerned it is fixed entirely beyond control. Except by making use of his hands to move it, or by placing it in such a position that the weight of the limb can bear upon it, he has not the least power over it. The spasm does not yield until the cause has been removed by manipulation, or by other suitable measures. It is the direct result of the strain; the muscles and nerves are stretched, and their ends dragged asunder, either by the accident itself or by the displacement of some internal structure. This acts as a stimulus. The contraction is the result, and, until some relief is afforded, voluntary movement is out of the question.

The pain in sudden twists of the loin or neck, when, for instance, the head is quickly turned round for the purpose of looking at something above and behind, is in many cases due to this. The attack is always sudden; the pain very severe, often sufficient to make the patient cry out, and for the moment he feels as if it were impossible to move. Then the head is slowly and cautiously brought round again to the natural position with a perceptible sense of effort. In a few of these there is dislocation or rupture of some of the slender muscular slips that lie by the side of the vertebral column, or bruising of the delicate tissue round and between the smaller joints. Accidents of this kind are well known to occur occasionally, and some instances have been already mentioned. At first the symptoms are very much alike, but there is rarely any difficulty in distinguishing them afterward. The cramp due to a sudden strain disappears much sooner than the others; relief is rapid and often spontaneous; a feeling of soreness may persist, it is true, for days, but the part can be used at once with a fair degree of freedom. In the other cases, owing to the tearing and laceration at the time of the injury, the effects are much more serious. They last a longer time, and it is often necessary for the patient to submit to a long and careful course of treatment before the part is recovered sufficiently to be used again with comfort.

The muscular cramp, which is so common after unusual exertions, among those especially who have a tendency toward

gout, bears a close resemblance to this. It is true that the immediate cause is very trivial, as a rule, and that the contraction rarely involves the whole of the muscle, but the difference almost disappears if due allowance is made for the condition of the tissues at the time. Instead of being fresh and active, they are tired out from overwork; waste products, probably of an acid nature, accumulate in their substance, and there is need of a long period of repose before the blood circulating through them can restore their strength and vigor. In these circumstances a very insignificant stimulus is sufficient to excite contraction. Merely holding the limb in an awkward position will cause it. Some fibres are unduly stretched. Suddenly they swell up, become hard, nodular, and painful; and then, as they tire themselves out, slowly relax and become soft again, leaving the part sore and tender. The muscles, which preserve the most perfect sequence of action so long as they are fresh, become more and more irritable as they are exhausted, so that their fibres are thrown into a state of irregular and spasmodic contraction by stimuli, which, under ordinary conditions, would not have the least influence on them.

The remedy is to straighten out the muscle quietly, but firmly, with as little delay as possible. The patient is generally unable to do it for himself, and then it must be done for him. The head, for example, must be steadily and firmly brought round until it faces the opposite direction. If this is done before complete rigidity sets in the pain and tenderness are much less severe. At the same time great relief may be obtained by kneading and rubbing any hard or contracted mass that can be felt under the skin, the pressure following the course of the fibres until they relax and become soft again. Where the resistance is very obstinate spongiopiline, or flannel wrung out of water as hot as can be borne, may be applied with benefit, and if the tenderness is extreme the rubbing may be continued with an anodyne liniment. As a rule, it is fairly easy to make the contraction subside, but it is as well to caution the patient to be careful afterward about the position in which the part is held. If the muscle is slightly strained again, or kept in a state of tension before recovery is perfect, the cramp is very likely to return at the same spot, and be much more painful.

It does not seem improbable, from what is known of the

use of massage in restoring the energy of overworked muscles and relieving the pain of sudden strains, that great benefit might be derived from it in those cases in which the limbs or particular groups of muscles are liable to be seized with cramp at frequent intervals, without there being any definite cause to account for it, other than the presence of some impurity in the blood. It has a most wonderful influence on the circulation and nutrition; it relieves the exhaustion of fatigue more thoroughly and rapidly than anything else; and it is only reasonable to think that if it were systematically applied the same effects would follow in cases such as these.

Tonic Contraction.—Muscular rigidity after sprains is not, however, always instantaneous or spasmodic; sometimes it comes on quietly and slowly, and persists without any apparent relaxation for an almost indefinite time. It is not painful so long as it is left alone; the joint is merely held rigidly fixed in one position until the tissues become wasted and spoiled for want of use.

In Children.—One variety is often met with in children, and, as Paget has shown, may be regarded as in some degree the result of fear, though it can hardly be due to this alone. The main features in the history are nearly always the same. Some joint has been slightly strained; perhaps it is the elbow, owing to the way in which children are swung round by the hands. A few days after, it is noticed that the arm is held continuously in one position, and then it is found that the muscles on one side of the limb are in a state of rigid contraction, which is maintained so long as the child is awake. Any attempt at straightening it out meets with steady resistance and a peculiar elastic recoil. If the attention is diverted, or, in a still greater degree, if the child is placed under the influence of an anæsthetic, the joint can be moved freely and easily, so that it is clear there are no adhesions or fibrous contractions round. Nothing is out of place; there is no sign of inflammation; the stiffness is purely muscular. It cannot be called voluntary; children cannot, by any effort of will, keep a limb straight and rigid for hours; nor is it due to reflex disturbance starting from the joint, for not only does it involve muscles (*e.g.*, the extensors of the knee) which would never be involved in this way, but the contraction shifts at times rapidly from one set to another, and even from one joint to another.

It is not even necessary that a joint should be involved at all. One of the most obstinate cases I have ever seen was in a boy who had a small ganglion on the back of his wrist; this had been ruptured subcutaneously twice before, but each time it filled again, as they often will. If it was even touched, all the muscles on the back of the forearm quite involuntarily became rigid, so that any attempt at bending the fingers caused severe pain. When the ganglion was removed all the contraction disappeared at once, and did not return.

Now, in some instances, no doubt, this is the unconscious result of fear. The joint has been hurt once, and the child instinctively keeps it stiff to prevent its being hurt again. But this is not all. The child really has not the power of straightening out the muscles, and the longer the case lasts the more marked the inability becomes. Voluntary control is not yet throughly developed. The emotional side of the mind is stronger than the will, and muscular contraction such as this takes place because there is not the power to help it.

The diagnosis seldom presents much difficulty. Self-consciousness in children is not perfect enough to be constantly on its guard; sooner or later something occurs to distract their attention from themselves, the crippled limb is forgotten, and the rigidity vanishes, to return again instantly if the part is touched. In sleep, too, it rarely persists, and it is seldom necessary, even in the most doubtful cases, to resort to the use of anæsthetics. It is quite exceptional in them for the contraction to last long enough to excite any organic change in the muscular substance or the structure of the joint; and the mimicry of inflammation is rarely perfect. Either the position is exceptional, as when the knee is kept straight instead of flexed, or the temperature of the skin is never raised, or something so unusual or incongruous is present, that the suggestion of serious joint disease is put out of court at once.

Treatment.—In many of these cases, where, for instance, a limb has been kept obstinately fixed in one position for some length of time, it is almost impossible to dispense entirely with the use of splints, but it is as well to employ them as little as possible. The object is to strengthen the limb, and to accustom the muscles to act in obedience to the will, not to confine them or to restrict their action. Much more may be effected by quietly making the position of the limb uncomfortable, varying

the method according to the particular circumstances of each case. A mild counter-irritant, for example, may be applied in the angle where one surface presses on another: this is generally sufficient to induce the patient to alter the position of the limb, without anything further, but care must be taken not to blister the skin, which is certain to be soft and tender at this spot.

In other cases it answers better to leave the contraction entirely alone, and to divert the attention successively to different parts of the body. I have seen several instances in which this method of treatment has been followed by conspicuous success; and though the cure may not have been permanent, yet time was gained for the adoption of other measures, and the danger of degenerative changes avoided. Quite recently, two children were brought to me separately on the same day for exactly the same affection. In each a knee had been sprained some time before, and the limb had become stiff and rigid in a position of extreme extension. The least attempt at bending it caused severe pain. There was no heat or redness, or any sign of inflammation, and certainly there was no displacement. Acting on a suggestion of one of the friends, a small blister was placed in each case on the knee of the opposite leg, with the best result; free movement returned within twenty-four hours.

It must not be forgotten, however, that this method of treatment does not aim at permanent success; it merely relieves the symptoms of the moment, and prevents the occurrence of serious after-consequences. It has no influence of any kind on the real cause, which is nearly always some disordered condition of the general health. Until this is set right by measures, which, of course, must vary in each individual case, it is almost hopeless to look forward to any lasting benefit from other plans.

In Adults.—Muscular rigidity of this description is not confined to children. It is nearly as common in young adult life in one sex as well as the other, and is liable to be followed by consequences of a much more serious character. Sometimes it come on suddenly, so that the patient on waking up of a morning is unable to straighten out a limb; sometimes it is so slow and gradual that no one can quite call to mind when it first appeared; there has only been a stiffness, increasing

gradually from day to day, until some accidental circumstance calls attention to it.

Many of these cases resemble, in their chief features, those already described. They are in reality the result of defective voluntary control. Mental power has either never been developed thoroughly or else it is not exercised. It may be that it has remained in the state so characteristic of childhood, or that it has become entirely subordinate to an excessive longing for sympathy. Whatever it is, the cause is not any mischief in the joint; there is no disease or inflammation in the part, though there may be a close resemblance to it. However serious the final result, and it may end in complete loss of use, at any rate at the beginning, the contraction can only be regarded as the local expression of a constitutional weakness, which may show itself in a variety of ways.

Simulation of Joint Disease.—The most striking feature about it is the way in which it can imitate real disease. The resemblance is sometimes extraordinary. In the one case the joint is inflamed and the muscles are tightly contracted, because the least movement of the bones causes intense pain; in the other, the rigidity is merely the act of an emotional or an excited frame of mind, of little importance in itself, and serious only in proportion to the likelihood of its continuance and the secondary changes that follow. Yet the difficulty is sometimes extreme, and it is not lessened by the fact that it is advisable to come to a definite conclusion, and adopt suitable measures as soon as may be. Whatever the cause, if left to itself it is a condition only likely to become steadily worse.

Fortunately, the evidence, if it is properly interpreted, is clear and distinct in the great majority of cases. In some, the first glance is enough. There is a certain order and regularity present in the symptoms when a joint is inflamed; they vary, it is true, according to the joint, but, for each individual one they are fairly constant, and if there is any glaring inconsistency, such as is met with sometimes, the idea of inflammation may be set aside without hesitation. In others, however, the question is not so easily answered, and it is only after repeated examination and the most careful weighing of evidence that such a conclusion can be formed.

The previous history is of very little use. Very often, without the least intention of deceiving, it is entirely mislead-

ing. If at any time, no matter how remote, there was an accident, the symptoms are always dated from it, and if nothing deserving of such a name can be remembered, repeated questioning is sure to suggest it at length. It is only in accordance with human nature that, as a result of continued trying, vague recollection should become a definite picture, the details growing more and more circumstantial each time until the whole thing is clear, and the friends at least are thoroughly convinced. As a matter of fact, it is not unusual for them to be much more certain on such a point as this than the patient himself.

Nor is any great degree of help to be derived from the position of the limb. In cases of emotional contraction in children it is often unusual or inconsistent with the presence of inflammation, as when the knee is kept rigidly extended, but in adults it is commonly identical with that assumed in real disease. So with the locality in which pain is felt. This may correspond exactly, even in such strange features as pain on the inner side of the knee when the hip joint is inflamed.

Sometimes the difficulty is increased by the addition of symptoms that are ordinarily regarded as characteristic of inflammation. The part, for example, may be swollen, and the temperature of the skin raised; there may even be a distinct blush upon the surface; but close examination, even in cases such as these, nearly always reveals their true character. The increase in size, for example, is never very distinct; often it appears to be more considerable than it is, from the wasting of some of the tissues and the passive collection of fluid in others; the rise of temperature (which should always be estimated by a surface thermometer; the hand may easily be deceived) is never above that which is normal in the more protected parts of the body, and the blush, if it were really due to inflammation, would indicate a degree of severity that is certainly not present.

In many instances information may be gained from the length of time that has elapsed since the accident, or at least since the commencement of the symptoms. Muscular rigidity is one of the earliest signs of inflammation, but it never remains the only one. At a very early period others are sure to make their appearance, and as they become more numerous and more marked the diagnosis becomes more easy. Emo-

tional contraction, on the other hand, may last for an indefinite period with no further change than that which has been already described as the result of prolonged inaction.

Unhappily the methods that are so successful in children do not give nearly such certain evidence in the case of adults. In the former it is, comparatively speaking, easy to divert attention from a suspected joint, so that if it is not inflamed the tonic contraction of the muscles quietly disappears and the angle changes. In the latter it is much more difficult. Chance moments of forgetfulness seldom present themselves in them, and the case may be watched for a very considerable time without any change being detected.

Sometimes after all the evidence has been carefully weighed it seems impossible to arrive at a definite conclusion. There is then only one alternative; the patient must be placed under an anæsthetic. This rarely fails. The joint may then be examined without the least pain; the muscles are completely relaxed; the movements are not interfered with; and it becomes possible to ascertain definitely how much of the rigidity is due to spasmodic contraction, and how much to other causes. It often happens that a limb, apparently as rigid as a bar of iron, becomes perfectly flexible as soon as sensibility is lost.

There is, too, as Paget has pointed out, another advantage to be gained by doing this. Valuable information may often be obtained by carefully watching the condition of the muscles while the patient is coming round again. If the rigidity is due to the pain of an inflamed joint they begin to contract and steady the bones long before consciousness has returned; and they do it so gradually and imperceptibly that it is almost impossible to say when the change commences. The rigidity is an instinctive act, independent altogether of the mind or of the higher cerebral centres, and it returns of itself long before these have reassumed their influence. When, on the other hand, no such cause is present, the relaxation continues until some notice is taken of it; then it disappears almost instantaneously, and the muscles become even more rigid than they were before.

At first sight it appears improbable, but it is, nevertheless, true, that the danger of overlooking the presence of inflammation is not nearly so great as that of imagining that it exists when the real cause is the lack of voluntary control and pro-

longed disuse. It is, comparatively speaking, rare for disease even of such an obscure and deep-seated joint as the hip, to be mistaken for hysteria; the opposite is much more common.

Not Merely Hysteria.—This, however, is not the only reason why these cases of emotional contraction deserve special attention. There is another danger to which they are exposed, scarcely less serious and infinitely more frequent. It is one of the commonest mistakes to regard a case in which it is clear there is no inflammation, merely as hysterical, and to dismiss it summarily as the product of some transient phase of mental emotion. The joint is hysterical, and that is enough; local treatment is not required; indeed, it is considered by many to be actually injurious, as it tends still further to attract the attention of the patient to the part; general measures only are recommended, and the contraction is left entirely to itself.

The result might be anticipated. As I have described already, a part that is kept at rest and never used cannot remain healthy; certain changes inevitably make their appearance; they need not be gross ones, or produce conspicuous alterations; the nutrition of the part suffers, and that is quite enough; the tissues are impoverished and lose the power of working with that complete unconsciousness and absence of effort which is so characteristic and striking a feature of health.

A good example of this may frequently be met with in the case of the arm, because, from the ease with which the shoulder-blade moves upon the chest the shoulder-joint itself can be kept almost at rest for an indefinite period without attracting much attention. The patient is almost always a young girl; there may be a history of injury; more often this cannot be relied on; or there may have been some mental trouble. At any rate, there is sure to have been something that either receives, or wants, the constantly and loudly expressed sympathy of others. The symptoms at first do not seem in any way imperative; there is always a certain amount of pain, which is borne with much resignation; and the movement of the part is constrained and awkward, especially when any attempt is made to raise the hand above the level of the shoulder; but there is nothing apparently serious until the part is examined and compared with the opposite side. Then it is found that all the time the shoulder-joint itself has been kept perfectly quiet, and

that the clumsiness is due to the attempt that has been made by one joint to supply the place of two. The muscles are wasted; the bony prominences stand out unduly; the rounded contour is lost; the arm cannot be lifted from the side; rotating the limb is almost impossible; the soft tissues round the joint have become firm and unyielding, and the patient is unable to raise the hand to the back of the head. The joint is almost rigid; the whole of the movement, or nearly the whole, is apparent only, and is really due to the freedom and ease with which the shoulder-blade glides upon the chest.

A joint in this condition cannot be called hysterical. It is of no consequence whether it originated in hysteria or not. The starting point of the contraction may have been an injury, or it may not; that has nothing to do with it. The joint has been kept at rest and never used; its tissues are starved and wasted; and they are unable to do their work. It is no longer a question of want of voluntary power; the muscles are rigid and the soft tissues round are stiff and unyielding; and until their natural condition is restored by local measures the part cannot work, whether the patient has the power to will it or not. The fault may have been that of the patient originally, but now it has passed entirely out of her control.

This is even more serious than it appears at first sight. A joint that is stiff and painful is always liable to become the seat of hysteria, even when this is not the cause. The patient's health suffers; every attempt at movement causes pain; the existence of the joint is continually being forced upon the mind, it is impossible to forget its condition, and at length it may happen that from this alone, even in those who are, comparatively speaking, strong of will, a condition closely resembling hysteria, if not identical with it, becomes developed. It is for this reason that active, vigorous local treatment, such as I have described already in speaking of the effects of prolonged disuse, is so essential in the treatment of what are called hysterical joints. Until the nutrition is thoroughly restored, and the tissues have recovered their natural power, it is hopeless attempting to effect any improvement by general methods. The two lines of treatment must be carried on together; one without the other is almost useless. It savors of the ridiculous to assure the friends of a patient that if the condition of the joint could only be forgotten recovery would follow at once,

when all the time the tissues are too wasted to do their work, and the least attempt at movement causes pain.

Muscular Contraction from other Causes.—Now and then instances are met with which cannot be explained by any of these causes. Some accident, apparently quite trivial in character, is followed by persistent muscular contraction, without the least trace either of hysteria or inflammation to account for it. One of these that came under my notice recently was in many ways most striking. The patient was a young man, tall, and of good muscular development. While at sea, about a twelvemonth before I saw him, he had strained his knee in getting out of the hatch. His account of the accident was perfectly clear. He had to take a step of great height to obtain a purchase for his foot, and to raise himself up at the same time with his hands; while doing this, pulling on his knee joint with all the strength of which he was capable, from a position of extreme flexion, he felt something snap; there was a moment of intense pain, and he fell back almost helpless. When his knee was examined it was full of fluid, but there was no displacement, and it was not locked. It was thought at the time that it was merely a sprain, and that if it was kept bandaged for a week it would get quite well. In spite of this, however, it was nearly a month before he could rest any weight on it; and even before this he noticed that the muscles which bend the joint were slowly contracting, and that he was gradually losing the power of straightening it out. This grew worse and worse, until at length he was so disabled that he was forced to lay up and consult a surgeon, who placed him under an anæsthetic and straightened the limb by main force. He could walk better after this, but he was still compelled to wear a leather splint to keep the joint extended. As soon as he left it off the knee began to bend itself in a manner entirely beyond control, and, of a morning particularly, it was only after great effort, and with much pain, that he was able to stand upright. To complete his misfortune, he had slipped off the curb-stone and sprained his knee again only a few days before. Since this the loss of control had been worse than ever; it was only with the greatest effort that he could get the limb straight at all; the morning that I saw him he had fainted twice in the attempt; his health was failing, and he was reduced by pain, and by the loss of his appointment, almost to a state of despair.

On removing the splint it was at once apparent that the whole limb was wasted to a certain extent from pressure, but mainly from disuse. There was no discoloration, swelling, or pain; and the only tender spot was the one on the inner side of the knee cap, of which almost all patients complain. The muscles on the front of the thigh had suffered most severely; the flexor ones at the back felt unusually firm and hard, though their bulk, as compared with those of the opposite side, had diminished too. The strangest thing was, that while looking at him, the knee gradually began to bend, until in about three minutes it had reached a right angle without the patient having the least power of preventing it. The movement was perfectly smooth and quiet. There was no cramp; the hamstrings felt somewhat firmer, and that was all. It required the exercise of very considerable strength to bring the limb again into a straight position.

I recommended at first that the limb should be thoroughly encased in a plaster of Paris splint, thinking that the muscles would soon become tired out by the unyielding resistance, assisted by the pressure, but it was of no use; and after being on for a few hours it had to be removed on account of the pain. It did not seem advisable to try the action of local sedatives; the case had lasted too long for them to be of any permanent service, and the patient would not submit again to an anæsthestic, so that it was not possible to manipulate the joint freely. Under these conditions I determined to try the effect of faradization, applied to the weaker muscles on the front of the limb, and met with the most surprising success. During the first application he was able to extend the limb with much greater ease, and after the third he could do it himself, when the current was not being applied. In short, he was completely cured, and returned to his occupation, though the limb, when I saw him again some months later, had not yet regained its normal proportions.

There can be no reasonable doubt that in this case the muscular contraction was the result of the sprain, though unhappily it was impossible to ascertain what was the precise nature of the injury that had befallen him; and no one who saw him, and who witnessed his anxiety to return to duty, would have entertained for a moment the suspicion of hysteria. What may have been the explanation of the unbalanced con-

traction is very doubtful. It seemed as if the nerves supplying the weaker muscles were unable to convey a sufficiently powerful stimulus; that, to use the phrase adopted by Vivian Poore in his Bradshawe lecture, they were blocked, so that the tonic contraction of the other muscles gradually overcame them. The muscular substance itself seemed equally affected on both sides of the limb, so that it could scarcely have been due primarily to this; and there was no reason to believe that the mental determination of the patient was in any way defective. It is possible, it is true, that a condition of irritation may have been induced in one of the nerve twigs supplying the interior of the joint by the changes following the sprain, and that it had travelled, after the fashion of the neuritis decribed by Erb, to the muscular branches supplying the flexors, stimulating them to increased and disproportionate vigor; but, if this were the case, it is difficult to understand how it was so easily cured. Whichever explanation is correct, it remains an example of muscular contraction, persisting for over a twelvemonth after a sprain, not due to inflammation or hysteria.

CHAPTER XVI.

MUSCULAR WASTING.

WASTING of the muscles is another common consequence of sprains. They lose their tone; the firm elastic sensation when they are pressed on with the finger disappears; they feel soft and pulpy; their strength diminishes and their size decreases until, in extreme cases, they may seem to have disappeared altogether, so plainly and distinctly does the outline of the bones show itself through the skin.

Degeneration from Disuse.—There may be many different reasons for it. Want of exercise, for example, may induce it. A limb kept perfectly at rest and never used, of course, must waste. The structure of the tissues degenerates; they either become infiltrated with fat or replaced by it to such an extent sometimes that the real amount of wasting is concealed. The muscles in some cases appear to retain their normal shape and size; the outline of the limb is nearly perfect, but the vigor and strength are gone, and everything feels soft and inelastic to the touch. In others, when, for instance, the patient is suffering from some disease that drains all his strength away, the wasting is so extreme and the amount of fat deposited so slight that they seem to have vanished altogether, and to leave the bone covered in by nothing but skin.

This change is a general one; it affects all the muscles—indeed, all the tissues of the limb alike; no set or group suffers perceptibly more than the rest; and unless the constitutional affection from which the patient is suffering is such as to preclude it, the prospect of recovery, so far as the muscles are concerned, is exceedingly good, even in extreme cases. There is little or no destruction of the living active portion of the muscle. No matter how diminished in size or strength the residue may be, as soon as it is exercised and the circulation through the limb increased by general treatment (especially a liberal

supply of food), assisted by local measures, such as massage and galvanism, the size and strength return, and in the majority of instances the whole of the former vigor is regained. I have seen this happen on more than one occasion when there literally did not seem a particle of muscle left.

Wasting from Compression.—Wasting of a description in some respects similar to this occurs with great rapidity under the use of constant compression. The worst form is caused by the constriction of an elastic bandage. Sometimes after sprains it is thought advisable to wear one of these. If there has been a great deal of effusion into the cavity of the joint, especially if it has been allowed to remain unabsorbed for any length of time, the capsule becomes softened and stretches until it fails to exert any pressure on its contents. It becomes loose and flaccid, and there is a continual sensation of insecurity and want of strength. The joint itself is actually firm enough, but the patient does not feel that it can be trusted as it was before. What is the reason of this is not certain; it is probably dependent on the nerves that supply the joint, for the same complaint is made of muscles when the sheath of their tendons is distended; and it certainly supplies a very strong argument in favor of removing the surplus fluid from a joint after an injury, by some means or other, with as little delay as possible. However this may be, when the capsule has been left in this condition a patient often feels the greatest comfort from the use of an elastic support, such as an anklet or knee-cap; and, wearing it at first only when he is taking exercise, gradually continues it until it is scarcely left off, even at night. The result may be imagined. In a short time a wasted band is seen all round the limb corresponding accurately to the size of the elastic; the superficial structures are more affected than the deeper ones, owing to the way in which the blood is kept constantly squeezed out of them; and where a muscle lies next the skin, with a broad flat surface of bone beneath, it is wasted to such an extent that its presence can scarcely be recognized, and years may elapse before it recovers. Such appliances may be used when any very unusual degree of exertion is undertaken, for just the same reason that laborers strap a piece of leather tightly round the wrist, but nothing can be worse than wearing them habitually.

These kinds of wasting are not limited to sprains, and their

influence is not confined to the muscles; they are due to general causes, and affect all the tissues of the limb, though, owing to their vascularity and softness of texture, there are differences in degree. Others are the direct consequence of these injuries, and are different in many points. They have no relation to disuse; are not the result of compression; do not involve equally all the muscles of the limb; are not due to fatty degeneration; and what is more serious and more important than all the rest together, unless active measures are taken, sometimes show little or no tendency to recover.

Wasting of Extensor Muscles Only.—One of these affects the extensor muscles almost exclusively, and is remarkable both for the very early period at which it shows itself and the rapidity of its progress. I have been able to detect a distinct change in the tone of a muscle three days after a sprain, and it is common for the diminution in size to be visible at the end of a week. Simple rest, no matter how complete, does not produce the same result in anything like the time. The wasting, too, is often extreme; a few weeks after the receipt of a strain or blow the bony prominences may stand out with great hollows between, so as, for the moment, to give rise to the idea that something is out of joint.

Only the extensor muscles are affected, and the broad ones of coarser texture, such as those covering over the hip or shoulder, suffer most, even when full allowance is made for the peculiarity of their shape. In these two situations in particular the effect is so considerable that it rarely escapes notice, and often is sufficient to attract the attention of the patient even before anything is said about it.

At first the wasting is limited entirely to this particular group; the deltoid, for example, which gives the shoulder its smooth and rounded outline, is the earliest to show the change; then it spreads to those that cover in the shoulder-blade behind. Only after it has lasted some considerable time does it involve the rest, and, as the whole of the limb is affected more or less, then probably as the result of confinement and disuse rather than anything else. The atrophy, too, in these cases is simple, and bears no relation to fatty degeneration. This may set in later, and involve all the muscles of the limb, especially if it is allowed to remain unused for any length of time; but as Valtat, in particular, has shown, both by experi-

ments and clinical observation, the two processes are essentially different.

Many suggestions have been offered in explanation of this, but the most reasonable is that which refers it to influences exerted through the nerves supplying the joint. Some have supposed, as it is common in the shoulder, that it is the result of injury to a nerve which winds round the bone in such a position that it might easily be bruised in falls or strains. But even if this were to happen, it does not follow that the muscles would become wasted in this way. They certainly do not when the ulnar nerve is bruised, and, as a matter of fact, the wasting is not limited to the muscles supplied by this particular branch, but involves all those which straighten out the joint, and which are not in any way connected with it; nor would this explanation be of any service in the case of other joints, such as the hip or knee.

Wasting from Inflammation.—Wasting of this description may be taken as a sure sign that the joint is inflamed, or, more correctly, that it has been, for it continues after the other symptoms have subsided. Its degree and rapidity depend mainly on the cause and severity of the attack. When this is but slight, affecting the vascular tissues of the joint only, or due to such transient local causes as the tension set up by the accumulation of fluid in the interior, it is least marked. If, on the other hand, the deeper textures of the joint, particularly the cartilages, are involved, or if the cause of the inflammation is some condition of acute blood poisoning, it is rapid and extreme. In children it is not common, unless at the commencement of strumous disease. Atrophy of the extensors never fails to appear early in this, though, owing to the slowly progressive nature of the disorder, it is often some time before any well-marked degree is perceptible. In adults it is most often seen in those who, later in life, are subject to attacks of rheumatic gout; and its importance depends in great measure on the warning it gives of this. In itself, it is merely a sign that the joint has been inflamed; it means nothing more, and it gives no indication of the cause. But subcutaneous injuries, such as sprains, are so rarely followed, in young and healthy adults, at any rate, by this complication that when it does occur the existence of some additional reason is always to be suspected. Occasionally it is the

outcome of indiscretion, or of some mistaken method of treatment; sometimes it is due merely to tension, but most frequently when inflammation and wasting follow a simple strain there is a history of gout or rheumatism, or both together. The injury assists the constitutional predisposition by selecting the part to be attacked, and, as it were, antedates the outbreak; in after years, as age advances, it is generally found that assistance of this kind is no longer required, and similar attacks, producing even more severe degrees of wasting, occur independently, without any blow or strain to excite them.

I have known this happen on many occasions. The patient generally gives a history of a sprain or of some unusual or sudden effort a few days before. Very likely nothing is felt at the time; but at a few hours later there is a sense of uneasiness and stiffness about the joint. It is not sufficiently severe to occasion serious anxiety; often there is no complaint about it until the question is asked; but yet it does not get well. Then quite suddenly, ten days or a fortnight after the accident, the condition of the muscles is noticed for the first time. The signs of inflammation may still be visible, or they may have already passed away, leaving the wasting and a certain degree of stiffness; there may be a sense of insecurity and even pain, most severe at night and when the joint is moved, or some distention of the joint cavity; and even in a few instances a perceptible rise of temperature, or there may be other signs of what has been quietly going on; but, as a rule, they are so slight that the discovery is almost accidental, and the diminution in size is thought to have been even more rapid than it really is. In the case of a young officer, who had strained his shoulder while wrestling about a fortnight before, I was solemnly assured that the wasting had come on in the course of a night.

If left to themselves these cases sometimes, but not often, recover without further trouble; the effusion is absorbed; the muscles regain their tone; the stiffness passes off, and full movement returns. If, on the other hand, whatever may have been the original cause, the inflammation does not very soon subside, the changes progress and become exceedingly serious. At first merely the extensor muscles and the lining membrane of the joint are involved; but in a little while the cartilage that covers the ends of the bones and the bones themselves are

affected. Absorption takes place; the length and axis of the limb are altered; symmetry disappears; the movements lose their smoothness and freedom; the range is limited, and the muscles, not only round the affected joint, but also those of the whole limb, become atrophied. Changes of this nature are most often met with after middle life in persons with a strong tendency to rheumatic gout, but they are not confined to this period. They occur as well in young adults, and are sometimes even more acute in them, so that I have known the lower limb lose an inch of its length, and the patient become completely crippled by the pain and wasting round the hip within a twelvemonth of its having been sprained.

Wasting from Overwork.—Atrophy of muscle occasionally makes its appearance after prolonged overwork, and even after a single sudden strain. In the former case there is a great tendency for the wasting to spread from those that are first involved to others; and when this occurs definite and well-known changes are generally found to exist at the same time in the cells of certain regions of the central nervous system. It is certain that there is a connection of some description between overwork and these pathological changes, but it is not easy to say how close this may be. One may be the actual efficient cause of the other, or not improbably some grave constitutional disorder may be the real agent, and the overstrain merely determine the particular group of muscles in which the changes first show themselves. However this may be, there is no question that the exceedingly serious disorder known as progressive muscular atrophy not unfrequently makes its first appearance in muscles that have been subjected to a long and continuous overwork, such as those of the back in "hedgers and ditchers."

Wasting from a Single Strain.—Atrophy due to one single, sudden effort is not so common. I have seen one well-marked case in which the muscles of the upper extremities were involved. The patient, who was a man of good muscular development, had slipped suddenly down some steps while carrying a heavy weight in each hand. In trying to save himself from falling, he made a sudden and vigorous effort with his arms, jerking spasmodically upward the weight that he was carrying. The shoulders and arms were stiff and painful for some time, but nothing remarkable was noticed for about three

weeks or a month, when he became aware of loss of power and of wasting, which, when I saw him, was so extreme as to convey the impression that the whole substance of some of the muscles had disappeared. The affection was nearly symmetrical, that is to say, approximately the same portions of both arms were attacked, and they were those which it is reasonable to imagine would have felt the strain most severely in such an accident. It is possible, it is true, that the wasting was secondary to the severe compression sustained by the nerves, as they run down into the arm over the first rib, between this and the collar-bone, at the moment of the fall. Loss of power and permanent wasting of the muscles are sometimes occasioned in this way, as Dr. Vivian Poore has shown, though as a general rule such momentary compression is not enough. It must be continued for some time to cause so serious a result. But the muscles that were affected in this particular case were too distinct and isolated to admit of such an explanation. They were not torn in any way; there was no evidence of the nerves being injured. There was no loss of sensibility; the pain was not severe; there had simply been one single, sharp contraction; and as a result of this (or at any rate after this) the muscles rapidly wasted and lost their power. Unfortunately, I was unable to watch the case further, and so cannot say what effect galvanism and other treatment would have had, or how it terminated at last. I should think it not improbable that it ultimately ended in the progressive form.

Local Wasting.—Lücke has described the same thing as occurring in the great extensor muscle on the front of the thigh, from the effect of blows or sprains. The wasting may involve the whole of the muscle or only a part, one of the great divisions, for example, of which it is composed, or a smaller portion still. In a case that was recently under my care, a gap could be distinctly felt on the front of the limb, about halfway between the hip joint and the knee. It gave the impression that the muscle had been torn across, and never reunited, though, according to the patient's statement, which was quite clear and definite, it was impossible for it to have been produced in this way. The gap made its appearance slowly and gradually after a strain, nothing being noticed for some days, and it kept steadily increasing in width week by week. Moreover, the electric reaction of the whole muscle was depressed, and

there was a general loss of tone and firmness. Lücke, who has thoroughly gone into the question, has come to the conclusion that there is an actual loss of the contractile substance in these cases similar to that found by Valtat in the atrophy following inflammation of a joint. There is no neuritis or other affection of the nerves, and no extravasation of blood; the wasting may follow either a blow or a strain; and its rapidity is in no way measured by the severity of the injury. There is often a certain amount of pain of a rheumatic character, and not unfrequently a slight amount of effusion into the knee joint; but this is probably passive rather than active, allowed to take place by the relaxation of the capsule of the joint that always follows loss of tone in the extensor muscles. According to the same authority, atrophy of the capsule of the joint with stiffness, and, at a later period, wasting of the other muscles of the leg, are not unlikely to happen, especially in old people.

Muscular Impotence after Strain.—Another peculiar consequence of muscular sprains has been described by Duchenne under the name of functional impotence. It cannot be called atrophy, for, in the earlier stages at least, no gross lesion of any sort can be detected either in the nutrition or in the structure of the muscles. They merely become tired out, and give way with the slightest exertion, so that the joints are no longer properly supported, or the bones sufficiently braced together. Sometimes this is the effect of a single, sudden strain; more often it results from continuing to over-work muscles when they are weak and badly nourished; but it may be produced by blows, and even, it is said, by exposure to cold. At first there is only an indefinite sense of pain and weakness, but after this has lasted for some time the symptoms become more conspicuous. If there is the least exertion the affected muscle is thrown into a state of rigid spasmodic contraction. It does not relax as it ought to in its proper turn, and allow the joint to move smoothly and evenly, but remains tense, contracted, and often in a state of painful cramp. This lasts longer and longer each time until the change becomes permanent; the tendon stands out under the skin like a rigid cord; the subtance of the muscles wastes, and is replaced by a kind of fibrous tissue which grows shorter and shorter until the joint is fixed in one position, and a condition is produced almost identical with that which results from prolonged inflammation.

In the Spine. Lateral Curvature.—Functional impotence of this description occasionally occurs in lateral curvature of the spine; and probably is, in some cases, in no slight degree the actual cause, especially when the deformity sets in with great rapidity after a strain. In one instance under my observation, the patient, a boy of fifteen, was swinging by his hands from a horizontal bar, when he was seized with sudden pain running round the abdomen so that he felt sick and faint. After lying down a short time this passed off, and nothing further was noticed until, in a course of a few weeks, his back gave way to such a degree that he was scarcely able to hold himself upright. At no time was there any sign of inflammation or of disease of the bones; there was no bruising or tenderness of any description, so that nothing could have been torn; the joints were uninjured and the movements perfect; only the muscles, from the moment they had been strained, had altogether lost their strength. By a vigorous effort after a prolonged rest, they were able to get the back nearly straight again, but they were quite unable to maintain it; almost at once they began to relax and give way. There was no serious alteration in their structure, for under proper treatment recovery was rapid and complete; they had merely lost their power as the result of one single, but severe strain. Had the case been left to itself, there is little doubt the deformity would have continued to increase, and ultimately would have become permanent.

In the Leg. Flat Foot.—Functional impotence is still more common when the strain, instead of being momentary like this, is kept up for a considerable length of time day after day. The muscles then never have the opportunity of thorough rest and relaxation; they are continuously overtaxed; and degeneration, often permanent in character, is very likely to be the result. This is frequently seen in the common form of flat foot occurring at puberty. Duchenne has shown that of the arches of the foot the long one is maintained almost entirely by the action of certain muscles on the outer side of the leg, the peronæi. The posterior pillar of the arch formed by the heel is almost vertical; the anterior, made up of the bones which form the great toe, is long and slanting. When the weight of the body falls on the crown of the arch, the posterior pillar is fixed by the pressure; the other would slip forward,

and allow the arch of the foot to sink down, if it were not for the muscles that hold it back. After long-continued standing, kept up for many days together, for many hours each day, these muscles, especially in a growing lad, gradually become tired out and yield. Then the tension falls on the ligaments, which, like all such structures when exposed to a continuous strain they were never intended to bear, stretch, and become the seat of acute pain, spreading up either side of the leg. Finally, they give way; the arch of the foot sinks, and the internal border becomes proportionately elongated. If, when this stage is reached, the peronæi muscles are examined, the tendons in which they end are found to stand out like rigid cords. Under the influence of the unceasing strain to which they are unequal, they have passed into a condition of permanent degeneration, probably identical with the contracture that follows inflammation, and now by their shortening form one of the great obstacles in the way of recovery.

I must not be understood to say that all cases of flat foot originate in functional impotence of the peronæi muscles caused by overstrain; but I am quite sure this is the chief element in a very large proportion, and I am able to confirm this by a case of my own, in which the cause of the loss of power was entirely different, but the effect the same. The patient, who was a strong, athletic young man, about a month before I saw him had received a severe blow on the outside of the leg, immediately over the middle of these muscles. No especial attention was paid to it at the time; there was a bruise, and that was all. But in two or three days he noticed that walking, and to a still greater degree standing upright, caused him considerable inconvenience. This grew worse and worse, until, owing to the nature of the trouble from which he was suffering not being properly understood, he was reduced to such a condition that he could scarcely walk six steps at a time. The pain was so intense that he was compelled to stop and lift his foot off the ground. This gave instantaneous relief, but the moment he rested his weight on it again all the old suffering returned. The description he gave was exceedingly clear. At first there was merely a general and ill-defined sense of aching, with a feeling of pins and needles running down the outer side of the leg; then his foot felt tired out, especially in the sole; the aching became more definite, and transformed itself into a

dull, numb pain, most severe behind the outer ankle, but spreading up the limb as high as the knee. The longer he stood the more intense this became and the wider the area it involved, until he was literally compelled to give in, and raise his limb from the ground. Throwing his weight on the outer side of his foot enabled him to walk a few steps further, and he always affirmed that a high-heeled boot enabled him to get about much better than a low one.

Careful examination made it plain that the cause of all his suffering was the injury sustained by this particular muscle. So long as it retained its natural strength, the weight of the body rested on those points of bone which are adapted to receive it, and which are held together by structures proportioned to the strain. The arch of the foot was as perfect as that of the opposite one. But when in a little while the muscle, unequal to its work, commenced to yield, the arch lost its main tie, and the anterior pillar began to slip forward until the whole of the strain fell on the ligaments, stretching them, and causing the peculiar sickening pain that always occurs under these conditions. Fortunately, in this particular case, the nutrition of the muscle was restored before either its structure had undergone a considerable degree of degeneration, or the ligaments had been seriously stretched, so that there was no serious sinking down of the instep. The pain was naturally less with a high-heeled boot, because the weight was then thrown more perpendicularly on the anterior pillar, and the strain on the ligaments was lessened.

Treatment.—The treatment of this complication of sprains requires the greatest care and consideration. It may be dependent on so many causes, and may be indicative of so many different pathological conditions, that of two cases, to all appearance identical, the one may recover easily and readily, the other may be merely a sign of the commencement of some serious disease. The first thing to determine in all cases is whether it is secondary to inflammation or not; if this is present nothing, of course, can be done directly to improve the condition of the muscles, as the majority of the remedies employed for restoring their strength and activity would only tend to aggravate the disorder of the joint. As soon as this has passed away, there is nothing peculiar about the atrophy it leaves, except the ease with which it can be cured in the

earlier stages, and the extreme difficulty it presents in the later after degeneration has set in.

Question of Inflammation.—The best evidence that inflammation has subsided is afforded by the temperature of the skin, as compared with that of the corresponding point on the opposite side of the body. This can only be done satisfactorily by means of a surface thermometer, carefully packed; the hand may be deceived, but this scarcely can. The points chosen must exactly correspond, they must be under the same conditions of exposure, and the rise must be a distinct one. It is not well to attach too much importance to slight alterations if other signs are not present. It seems as if certain people, by directing their attention constantly to one part of the body, possess the power of raising the temperature to a slight extent, probably through dilatation of the blood-vessels, so that from this alone it becomes slightly warmer than its corresponding area. At least, I have on several occasions witnessed phenomena of this kind, for which I could find no other explanation; and the suggestion is quite consistent with what is known of the influence of the mind on other parts, as, for example, the lungs in cases of phthisis. As a rule, if the difference is inconsiderable and variable, it may be taken for granted that inflammation is not present; and that the sooner passive movement and more energetic treatment are adopted, even to the extent of forcibly breaking down adhesions, the better the prospect of recovery.

As I have shown already, in speaking of joints, the danger is that, disregarding the positive evidence of the thermometer, and relying on the fact that movement is painful, it may be imagined that inflammation still continues, and that further rest, with its inevitable consequences, further atrophy, is advisable on that account. The mistake is the more serious, as under such conditions the rigidity is constantly increasing, so that the prospect of recovery, when at length an attempt is made, is even more remote than it was before.

Local.—The local treatment of muscular atrophy is for the most part identical with that which has been described already in speaking of the condition of disused and stiffened joints. Everything is of service that helps to exercise them and to improve the circulation through them. Passive motion, working each of them alternately, first in one direction and then

in the other, sometimes with, sometimes without resistance; stretching them out; massage, in all its forms, especially those which influence most the deeper-lying strata; ironing; bathing and douching with hot and cold water; shampooing; friction with stimulating liniments; and even, were large masses of muscles are concerned, as in the back, acupuncture.

Galvanism.—One other remedy that has scarcely been mentioned yet may be used with the best possible result in many of these cases, and that is galvanism. It is true it is impossible for any one who is not a specialist in the subject to undertake to form an elaborate diagnosis, or to give a definite opinion as to the extent to which degeneration has spread in particular directions. But without attempting this, and even leaving special and unusual cases aside, there is no inconsiderable number of others in which it may be employed with immense benefit under the guidance of simple and ordinary rules. The object is entirely different. It may be impossible, without special education, to give an accurate opinion from the electric phenomena alone as to the condition of the muscles, and the probable course of the degeneration; but this is not what is wanted. The diagnosis has been made already. It is known from other symptoms that the atrophy is the consequence of certain definite causes, such as inflammation, which may or may not have ceased to exert their influence. This is sufficient in all ordinary cases. Galvanism is employed, like massage and other remedies, solely as a means for improving the nutrition of the tissue and restoring the energy to the muscles. For this it is one of the most valuable applications known, and if only there is a fair general knowledge of its use, and the method of its employment, it may be applied in a very large number of cases with the greatest benefit.

In Diagnosis.—It has been thought by some that electricity would be of service in diagnosing the presence of hysteria; that by its means it would be possible in any case to ascertain whether the loss of power is due merely to loss of will or to some actual lesion. If this were so, it would be of the greatest use; the difficulty is a common one and often very considerable. But, unhappily, it is of little or no use for this particular purpose. It does not enable us to discriminate in any definite way between the slighter forms of traumatic or pressure paralysis, and that which is met with in hysterical subjects.

When the atrophy is more advanced, and the degeneration plainly marked, the signs it gives are, it is true, much less equivocal; but the difficulty then has in great measure disappeared, and the diagnosis may be allowed to rest with safety on the other symptoms.

The Induced Current.—Faradization by itself is required only in exceptional cases. Its action, even when applied to the muscles, is mainly on the nerves and their motor ends, and this is rarely needed. I have mentioned one remarkable case in which it proved of value, restoring to full use, after a third or fourth application, a limb that had been almost crippled for over a twelvemonth There was apparently some obstacle to the transmission of stimuli down the nerve into the muscle; the influence of the will was not sufficiently powerful to make its way along it. One set of muscles was, in consequence seriously weakened, and the opposing ones, with their vigor unimpaired, kept the limb constantly contracted. Here faradization apparently opened up the path for the passage of other stimuli, so that full power of movement was regained. Such instances, however, in the absence of hysteria, are not common. When this is the exciting cause, faradization often proves a most effectual remedy; but it is not easy to say in such circumstances how far this is due to moral influences. Apparent paralysis of other muscles, at least where there has been no injury, is not unfrequently cured in this way.

In functional impotence, and in the early stages of the contracture that follows it, mild direct faradization sometimes restores the power more quickly than anything else; but, as a rule, the energetic and protracted action of a strong galvanic current answers better. Or, if a more powerful stimulus is desired, the positive pole may be applied over the muscle, and the current interrupted occasionally, and even reversed. I have had no experience of the simultaneous action of the galvanic and faradic currents, but from what is known of the refreshing influence of the former, and of the power it possesses of increasing the electric excitability of the parts to which it is applied, it seems reasonable to suppose that it would be of material assistance, especially in cases such as these; and by enabling a weaker current to be used would avoid the fatigue and exhaustion which might otherwise result. The alternate action of the two is certainly very successful.

The Constant Current.—For atrophy itself galvanism is more effectual than the interrupted current. It is a mistake to think that the beneficial effect of electrization is to be attributed in any way to the production of muscular contraction. If the nerve centres of the spinal cord are involved, it is impossible to prevent degeneration or wasting. The influence of the continuous current on their nutrition is to be attributed, rather, to its chemical action, to its influence on the circulation, and to the way in which it promotes the absorption of waste products and the regeneration of broken-down elements. As I have already pointed out, it must always be remembered that the nutrition of the tissues is ultimately dependent on the circulation of the plasma outside the walls of the vessels. The blood circulates in these, its fluid constitutents passing out through the walls and permeating the tissues in all directions. The muscular fibres lie embedded, as it were, in a fluid plasma, which requires to be constantly replaced, and its renewal is dependent much more on the activity of the tissue elements themselves than on the mere circulation through the vessels. This, without the other, is of little service. If the tissues are leading an active and energetic life, the circulation of the plasma is carried on at its best; if they remain sluggish and passive, it stagnates round them, the part is badly nourished, and the tissues become sodden and œdematous. In this condition of things regular and systematic employment of galvanism is especially indicated. Whether its influence depends on chemical process or not, it causes the swelling to disappear, quickens the circulation, brings back the color to the skin, and restores the activity of nutrition in a manner equalled by nothing else. Faradization may be used in certain cases, and, as already pointed out, is of great assistance sometimes in conjunction with the constant current; but so far as muscles are concerned in everything beyond the mere production of contraction, the latter is far the most useful.

Generally speaking, it is sufficient that the limb should be galvanized every other day, alternating it with massage for five or ten minutes each time. In certain cases it may be used more frequently, but there is often a tendency, especially on the part of the patients, to over-galvanize the limb. Disappointment must not be felt if it is some time before any decided improvement makes its appearance. The regeneration of

the tissues must be a slow process; absorption and nutrition may be assisted, but they cannot be hurried.

The strength of the current should always be moderate, though it is difficult to lay down any definite rules. It is not possible to be accurate without the aid of delicate and complicated instruments. Specifying the number of cells gives little or no idea; allowance, for example, must be made for difference in the resistance of the skin in different parts of the body. Where it is thin, or where there is a large number of sweat glands, the current passes much more easily than it does elsewhere; and the resistance diminishes with moisture, with pressure, and with the length of time the current is applied, this being due in all probability to the fact that after it has been passing some time the blood circulates more freely through the superficial parts. It should never cause the least suspicion of pain; if actual contraction is desired, each muscle must be stimulated in turn by applying the electrode to its motor point or points, as the case may be; or if the nerve that supplies the muscle is more easily accessible contraction may be produced in this way, but the weakest current that will effect this must always be used. In the case of galvanism the size of the electrodes is a most important consideration. The strength of current passing through the body from a certain number of cells is, other things being equal, dependent on the extent of their surface. Consequently, where there are large masses of muscle, as in the back, and where, accordingly, large plate-like electrodes are employed, a current of proportionate strength should be used. If they are large enough, and kept well moistened, there need be no fear of injuring the skin.

When galvanism is used, for its refreshing action, after faradization or to relieve the sensation of fatigue, the positive pole should be applied to a point more distant from the trunk than the negative in order to obtain as far as possible an ascending current. In other circumstances the cathode is placed directly over the structure it is intended to galvanize, and either held there or slowly moved over it in the direction of the fibres. The latter method is much more stimulating; the current is always varying in intensity, being most vigorous immediately under the electrode, and the energy with which it acts upon the muscles beneath is constantly changing as it moves over their surface; so that in addition to the chemical

influence it possesses it calls out moderate contraction of all the fibres in turn. The rapidity of the movement is as important in determining the amount of muscular contraction as the strength of the current, owing to the suddenness in the variation, when the position of the electrodes is changed.

Even when there is no atrophy galvanism has a very beneficial influence on sprains in their later stages. The action of the muscles, perhaps, is embarrassed; every movement is attended by a sense of stiffness and fatigue; the tissues are rather swollen; the skin feels cold, and the muscles do not respond readily. The injury has been repaired, it is true, and there is no definite alteration in the structure of the part, but it does not perform its function properly, and recovery is not perfect. The circulation requires a stimulus; the conducting power of the nerves is enfeebled; the muscles need educating again, as it were; their contraction is not orderly, as it should be; they do not assist each other, and the movement is not passed on from one to the other as smoothly and evenly as it is in health; the result is a sensation of pain, which prevents freedom of action, and by encouraging the patient to keep the part at rest delays convalescence more and more. Under these conditions the thorough electrization of the whole, using the interrupted and constant currents alternately, often effects a cure in a very short space of time, especially if it is assisted by massage. Nothing restores power and freedom of movement more easily or more quickly. If it fails, and there is no serious disease or inflammation to account for the persistence of the symptoms, the presence of some adhesion, too strong to give way before such mild measures, is to be suspected, and it becomes advisable to examine the joint under an anæsthetic.

GENERAL ORTHOPEDICS

INCLUDING

SURGICAL OPERATIONS

BY

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6—37

GENERAL ORTHOPEDICS.

INTRODUCTION.

A WORK devoted to modern orthopedic surgery will unquestionably be of great practical value to the physician and will fill a void. Marked progress has of late years been made in orthopedics, a branch of the surgical art, and on account of the frequency of deformities, it is a subject which should attract the attention of every thoughtful physician.

The physician who, during his student days, has not acquired the knowledge of and the readiness in applying bandages and apparatus will have cause for regret, for he will be frequently called upon to resort to these measures in his practice and it will not always be possible to send his patient to an orthopedic dispensary or surgeon. Although many deformities can only receive the requisite treatment at special clinics, or at the hands of the specialist who has acquired the essential technical skill, it still holds true that the subject, in general, should be the property of every physician. As v. Ziemssen says, "orthopedic methods belong to those which every physician should master; the technique should be thoroughly acquired and expertly understood." Further still, modern orthopedic methods are of greater importance to the physician than those of the past, when the more active operative measures were not countenanced to the same degree as obtained in other branches of surgery.

Owing to the fact that deformities are met with chiefly among the poorer classes, our aim should always be to resort to the simplest and cheapest therapeutic apparatus. Coulomb's words "il faut être démocrate du moins en orthopédie" are most apt ones, since the simpler the contrivance, the more accessible it will be to the majority of patients.

With truth did Bauer complain that many inventors take out patents for orthopedic apparatus, since "no liberal-thinking physician should place his inventions within the reach of the rich and deny them to the unfortunate poor." There is, however, scarcely any method of treatment with which fault might not be found; simplicity has rarely prevailed in orthopedics; ordinarily there is call for knowledge as to the technique of bandages and apparatus, for anatomico-physiological insight, for pathologico-anatomical research into the causal factors of deformities, in order to obtain a correct estimate of the obstacles in the way of treatment. The chief requirements, indeed, of our subject lie in a pathologico-anatomical and in a diagnostic direction.

I have borne in mind, in the preparation of a work on orthopedic surgery, the difficulties I would have to meet: the vast orthopedic literature contains much that is uneven and obscure, so that it is often difficult to pick out what is correct. Still it is not possible to neglect entirely the description of older methods and apparatus, since, in individual cases, these may be of value; but modern orthopedics has progressed to such a degree, that I have felt obliged to consult many different and not easily accessible contributions, all the more since many of them did not originate in Germany and are therefore not within the reach of most practitioners.

Through a careful statement of the etiology and the pathological anatomy of the subjects with which we are concerned, I have endeavored to expose clearly the methods of treatment, and to simplify early diagnosis. In the choice of illustrations (and it seemed to me essential to select a large number) I have aimed at picturing the slighter as well as the more uncommon grades of deformities, and at representing apparatus of the most varied nature, which the physician must order even as he does the drugs in his recipe, that is to say he must give the mechanic explicit directions, and herein the illustrations will be of much service.

I trust that the following exposition of orthopedic practice and methods may excite the interest of physicians in this branch of medicine, for orthopedics may be looked upon as a step-child of the other medical branches, and I hope it may obtain for orthopedic methods more general recognition.

CHAPTER I.

GENERAL ORTHOPEDICS.

UNDER the term orthopedics (from ὀρθος, straight, and παιδεια, knowledge) we understand the subject of the deformities of the human body and the methods of prevention and of cure, and we see at once, therefore, that it is not separable from surgery, but must be considered an integral portion.

As in every other branch of medicine, so in orthopedics was the growth gradual up to the present stand-points; and in addition to marked advances (such as tenotomy, osteotomy, etc.) there have occurred many serious errors (such as the forcible straightening of the spinal column, the cutting of the muscles in the treatment of skoliosis, etc.). The opinions which have obtained have been in many respects opposed, and in regard to many points there has arisen great and protracted discussion. Bias and egotism have stood in the way of the recognition of some methods, or else a method has been open to the charge of charlatanism. At times, indeed, our chief aim, that of helping our patient, has been lost sight of amid these disputes. In these respects, our subject is darker and more forbidding than other branches of the medical science.

To sketch briefly the chief points in the history of orthopedics, we must, at the outset, state that its inception may be traced as far back as can human deformities; Hippocrates, Galen, Arabic physicians, Ambroise Paré, Severinus Arcæus, —these all have yielded us considerable information on this subject. Fabricius Hildatus reports, among other things, a case of severe contracture of the hand which he cured by suitable apparatus.

In the year 1500, Glisson first resorted to suspension in orthopedics; in 1685, J. Minius first performed tenotomy in case of caput obstipum, and certain physicians of Holland (Tulpius,

Mekren, Roonhuysen), described orthopedic results in their writings.

Andry (1741) first collected the observations of his predecessors, and gave the science the name it holds to-day. In 1780, A. Venel opened, in Switzerland, the first hospital for the treatment of deformities; in 1782, Lorenz, on the advice of Thilenius, first performed tenotomy of the tendo Achillis in a case of club-foot, but this fact was forgotten, and Delpech must be considered the man who first established orthopedics on a sound basis.

In 1803 Scarpa devised the since much-modified Scarpa club-foot shoe. Jörg (1806), Rudolphi (1832), Palletta, Soemmering, and others added much to orthopedics by their labors; but the science only made essential strides after L. Stromeyer substituted subcutaneous tenotomy for the early method practiced by Michaelis, Delpech, Dupuytren and others. With Stromeyer, Heine, Dieffenbach, Langenbeck, must be mentioned as men who furthered the advance of orthopedics.

Little, who himself suffered from club-foot and was operated upon by Stromeyer, spread the new methods in England, and sowed the seed for the founding of the Royal Orthopedic Hospital, in which, during its first ten years, not less than 12,000 patients were treated. The first fruits of this enormous series of observations was the work of Tamplin, and his colleagues, Lonsdale, Brodhurst, and Adams, made further advances in our subject in England.

In France, the names of Bouvier, Margolin, Pravaz, Guérin and others must be mentioned, and Bonnet and Malgaigne added as much to the knowledge of the diseases of the joints as they advanced orthopedics.

In America, orthopedic surgery was especially advanced by L. Rogers, Detmold, Mott, and the latter had schemed the foundation of the American Orthopedic Hospital, although his desire was not fulfilled till after his death.

With the increase in the number of orthopedic hospitals (and almost every large city to-day has one) the interest of physicians in the subject increases, and it is highly to be desired that the schools should give special instruction in this, the youngest of all the specialties, for thus the knowledge of matters which relate to orthopedics would be increased generally among the profession.

As in every branch of medicine, however, we cannot attain our aim without effort, for many individual methods endeavor to secure pre-eminence, as for instance the Swedish gymnastic cure, which originated with Ling (1776 to 1839) and has been extended by his pupils.

Others, on the contrary, seek to work solely through mechanical apparatus, and in some respects Langgaard was right when he said, "I believe that the claims advanced for gymnastics alone should not be deemed progress in orthopedics."

For a long while there was great discussion over the dynamic and the mechanical methods (Schreger, Heine, Werner), until each had been assigned its proper sphere. Finally, the essential foundations of orthopedics were laid by the anatomo-physiological mechanical studies of Weber, v. Meyer, Hencke, and especially after the appearance of the works of Hueter, Volkmann and others.

The endeavor to accomplish what is essential by means of simple bandages, etc., has especially led to important advances and to betterment in methods. Of greater importance than the improvement of mechanical apparatus, of more utility than the introduction of subcutaneous tenotomy (although since this time dates, in truth, a new era for orthopedics), has been the introduction of the antiseptic treatment of wounds, the great discovery of Lister. This has widened greatly the bounds of orthopedics, and since we have learned that we can, for instance, break a deformed bone without danger and cause it to heal straight, we have obtained the most brilliant results and cures in the shortest possible time.

Through these operative measures we are in a position to cure cases which, at an earlier date, no one thought of attempting to treat, in the presence of which, indeed, the physician was formerly powerless. We must here refer to a number of methods of great importance in orthopedics; namely, the extension method of treatment devised by Volkmann, which has quickly obtained acceptance, the use of elastic traction (Bruns, Barwell, Blanc, etc.), and, above all, the jacket method of treatment of disease of the vertebral column, for which we have chiefly to thank Sayre; all these methods are very valuable therapeutically, in the great majority of cases, and they must be looked upon as essential advances in the subject of which we are treating.

These advances have led to the rejection of many ancient objectionable orthopedic methods of treatment; and have caused orthopedics to be considered to-day an essential part of surgery, and even of an importance from a strictly medical standpoint, and we have only to glance over the records of the first, as well as of the smaller clinics, in order to see what a great rôle orthopedics play. Special courses in orthopedics are offered the young physicians in order that they may acquire the information which will afterward be so useful to them, and it is in this connection highly to be desired that each hospital (like the New York Orthopedic and others) should have a special work-shop, for the preparation of apparatus, in direct connection with it.[1]

In the past few years, particularly, there have appeared a number of noteworthy works on orthopedics. I need recall only those of v. Meyer, Lorenz, Vogt, Margary, Noble Smith, Kocher, Lücke, Mikulicz, Roser, Romanit, and others, which are mostly founded on pathological and anatomical researches as applied to new methods of treatment.

We may define the term deformity, in general, as being a morbid change of form of some part of the bony skeleton, or as a deviation from the recognized configuration of the symmetry of the human body (Tamplin); many orthopedic affections, however, as for instance anchylosis, depend on an abnormal alteration of function in a portion of the body (stiffness, limited mobility).

In the majority of orthopedic affections we deal with a curvature, that is, the form of the affected part is so changed that it deviates from the straight line, and it is chiefly in the joints rather than in the bones that the changes are found (the so-called loxarthroses).

In general, in orthopedics, we have to deal with diseases of the organs of locomotion, disturbances and diseases of the bony system, of the joints and ligaments, or of the muscles, and we may thence divide orthopedic affections according to the system chiefly involved, and we may further subdivide the subject according to the nature of the change in form, according to the causal factors. Above all, according to the time of occurrence, we may subdivide our subject into the two great classes of congenital and acquired deformities, as in the following scheme:

Congenital Deformities.	1. Malformations, primary errors in development: *a*, Primary error in the germ, defect in formation. *b*, Disturbances in development of the normally formed fœtus through loops in the umbilical cord, etc. 2. Intra-uterine deformities resulting from: *a*, Abnormal position of the fœtus in the uterus (congenital luxation, etc.). *b*, Abnormal intra-uterine pressure. 3. Deformities resulting from disease during intra-uterine life (rachitis, etc.), or injuries (fœtal fractures). 4. Deformities following on traumatism during labor.
Acquired Deformities.	1. Such as result from essential disease factors or traumatic influences: *a*, Unsuitable clothing (ill-fitting shoes), etc. *b*, Abnormal posture and what may be termed deformities resulting from occupation. 2. Such as result from disease: *a*, Of the bones (rachitis, tubercular osteitis, etc.). *b*, Of the joints, the cause of which is arthrogenous. 3. Such as result from disturbances in localities removed from the affected region: *a*, In the muscular system (myogenous cause). *b*, In the central or peripheral nervous system (neurogenous cause) 4. Such as result from traumatic influences: *a*, From changes in the soft parts (cicatricial contractions, etc.). *b*, From changes in the bones and joints (deformity from fractures or dislocations, etc.)

The question of the origin of fœtal deformities is still in many cases very obscure; often we must suppose an error in the germ, a *vitium primæ formationis.*

An hereditary influence will explain certain congenital deformities (such as congenital luxations, club-foot, etc.). Tamplin, for example, tells of a family where there were eight children suffering from similar bilateral club-foot. In other instances we are dealing with a primary disturbance in development resulting from a fœtal disease, where, for example, a part remains rudimentary, or may even be entirely lacking, and so in the course of the development of the other parts we witness deformity. A good example of this character is offered by curvature of the fore-arm or of the leg, which results

from lack of development of a bone and which leads to distortion of the hand or foot. Such cases have been described by Mosengeil,[2] Billroth,[3] and others.

Those cases are very obscure (although in some the data are authentic) where a sudden maternal impression during pregnancy (fright at the sight of a cripple, etc.) has caused the deformity of the fœtus.

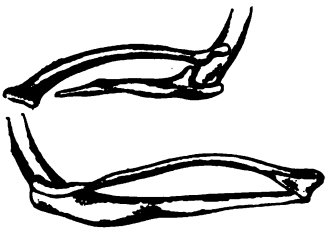


FIG 1.—Curvature of the Radius; Luxation of the Head of the Radius with Defective Development of the Ulna. (Humphry.)

Instances of deformity are better explainable which may be traced to loops in the umbilical cord, or to abnormal posture *in utero,* which is offered as an explanation of talipes, and where, at times, a deficiency in liquor amnii is determined, leading to abnormal pressure on the misplaced part.

The etiology of deformities which result from intra-uterine disease or from traumatism suffered during pregnancy, is readily understood, although we cannot give absolute credence to all the recorded cases.

A fair percentage of deformities are caused by unfavorable, purely external causes; we will see how the carrying of infants on one side predisposes to skoliosis. Camper, Soemmering

FIG. 2.—Congenital Infraction and Curvature of the Fore-arm. (Munich Path. Institute.)

and others claim that the tight chest bandages have an unfavorable influence on the muscles of the chest. The modern, faulty method of shoeing children (pointed tips with high heels to the shoes) leads to characteristic deformities, such as hallux valgus, etc., and may cause serious trouble.

In the great group of deformities due to abnormal and constant pressure (genu valgum, flat-foot, etc.) a weakness of the muscular system is an efficient cause. The most impor-

tant factor here is the abnormal, constant malposition, under the influence of which there occurs unequal growth of the affected limb, in that at the points of pressure growth is interfered with, while at other parts growth is increased, and genu valgum offers a typical example of this. In this connection H. v. Meyer [4] differentiates a relative excessive strain (as in rachitis), and an absolute effect of external factors acting on the body.

Habitual methods of holding the body may lead to asymmetrical growth, to curvature approaching skoliosis, as witness the deformities in certain artisans, in watchmakers, in stone breakers, etc., and this is the more likely to occur when the cause acts early in life, before the bony structure has attained its growth.

More important still are the deformities resulting from disease of such a nature as causes softness and bending of the bones (rachitis, osteomalacia), or such as leads to disturbances of the bone tissue (tuberculosis, osteomyelitis,[5] and again, syphilitic osteitis, rheumatism). The arthrogenous deformities, those which follow on inflammation of the joints, are more infrequent the better such inflammation is treated. We deal here, generally, with the affection characteristic of each special joint, as we will note when speaking of contractures. Bone disease following on causes which check or interfere with growth, such as necrosis, may also lead to deformities.

Of no less importance in the etiology of deformities is the effect of diseases and their sequelæ. Thus, disease of a muscle may lead to diminished function, and as a result of excess of strength in the antagonistic muscles there may result deformity, or the same may follow on a lasting spasm or cicatricial contraction (the so-called myogenous deformities).

More frequently the cause of paralyses and spasms lies in disease of the central nervous system, and the great group of infantile paralyses is due to meningitis, etc., that is to say, to disease of the cord, of the brain and its membranes.

Deformities less frequently result from affections of the peripheral nervous system or from reflex effects from disease of the genital organs. Sayre reports a number of severe instances of muscular contractures due to phimosis, etc. The cause of these myo- and neuro-genous deformities is very variable according to the extent of the process.

In regard to muscle-antagonism, it was the belief that in all cases where the antagonistic group obtained the ascendency a nutritive shortening or deformity resulted from the contraction of the muscles and from the approximation of the insertion points. Hueter and Volkmann, however, have shown that we are rather dealing with mechanical influences, that is, with the weight of the affected section of joint, the habit in walking and in standing; that such influences favor the occurrence of paralytic deformities, and that much depends on the manner after which the affected joint is used.

A further influence (and Seligmuller, among others, has laid stress upon this) is the fact that the paralyzed muscles are not able to redress the position enforced upon a joint by the non-paralyzed muscles, and consequently each movement in the direction of the latter is effective, and the resulting provisional contracture merges, in the majority of cases, into a definitive.

Where all the muscles of a joint are paralyzed, the condition becomes that of a movable joint; when such a joint is used, the check influence of the muscles is lacking. The movements occur to such a degree as the approximation of the bone surfaces to one or another side, and as the tension of the ligaments allow, and since this tension will ultimately relax, the ligaments become stretched, and the bone surfaces suffer change in their configuration, and the deformity is magnified.

We will not consider further paralytic deformities, but will only note the fact that frequently a number of conjoined causes lead to deformity, that is to say, combined etiological factors are at work.

In the small group of congenital deformities which result from trauma, there belong those caused by injury suffered during labor (for example, torticollis, the rupture of muscles during rapid delivery, on which Stromeyer has laid stress).

Of the injuries to the soft parts which come under our observation, it is particularly the cicatrices following on burns and scalds, that is the contractures, which concern us, and these most frequently affect the hands and fingers. Deformities also result from injuries to the skin of the most different kinds, such as abscesses, etc., and these are of great importance when they cause separation of tendons or of muscles; or when a motor nerve is involved and there ensues loss of its function.

We must mention further the deformities following on injuries to the bones. The most frequent are those which are the result of improperly treated fractures, also instances of fracture near the joints or inter-articular fractures, where proper manipulation or passive motion (massage) was not resorted to in time, or where a splint was worn too long.

The imperfectly reduced dislocations are infrequent sources of deformity, as is faulty union of fractures of the epiphyses.

The occurrence of deformity varies greatly, according to age and sex. The large proportion arise chiefly in childhood, and those due to external influences, as for instance, skoliosis, are met with chiefly in girls, while, on the other hand, those resulting from strain, such as genu valgum and pes valgus, occur with greater frequency in boys.

The symptoms of the deformity must naturally be specially treated, according to the demands of the individual contracture. As to the frequency of deformities, we need only recall the fact that Schrauth, in 1860, estimated the number in Bavaria as being 25,000. Werner claimed that there were 56,000 cases of skoliosis in Prussia, and he states that a census for England and Wales mentions no less than 409,207 deformed individuals, of which number one quarter, or 90,277, belonged to London alone. We see at once what a burden these deformed individuals are to the state, for it is not possible, as Dieffenbach[6] suggested, to utilize the club-footed as cavalry men. Many orthopedic diseases, further, render the sufferers partially or totally incapable of work, and unfortunately, the majority belong to the poorer classes. The deformity, again, reacts markedly on the individual himself. The state of the general health often suffers from direct implication of internal organs (as in aggravated skoliosis and kyphosis), and in instances of exaggerated talipes, etc., from lack of exercise in the open air. Further still, we must note the depressing effect of the deformity on the mind, a circumstance to which Tamplin[7] has well given expression. Indeed, in how many cripples is not the pyschical pain apparent in the physiognomy? Poor and rich, high and low, stand on an equality in this respect. How much pain did not Lord Byron's club-foot cause him! That master in depicting human feelings (Shakespeare) expresses this, among other places, in the opening monologue of Gloster's in Richard III.:

"But I,—that am not shaped for sportive tricks,
Nor made to court an amorous looking-glass;
I, that am rudely stamp'd, and want love's majesty,
To strut before a wanton ambling nymph;
I, that am curtail'd of this fair proportion,
Cheated of feature by dissembling nature,
Deform'd, unfinish'd, sent before my time
Into this breathing world, scarce half made up,
And that so lamely and unfashionable
That dogs bark at me as I halt by them."

On the other hand, it is well known that the intellectual faculties are apt to be highly developed, and many a distinguished man has been more or less deformed (Socrates, Æsop, Alexander the Great, whose head is said to have been turned toward the left, Burleigh, Pope, Talleyrand, Flaxman, Byron, Mendelssohn, etc.). Little was operated on by Stromeyer for club-foot.

In regard to the diagnosis in general, of deformity, in the vast majority of cases simple inspection proves its existence. Still it must not be taken for granted that the variety of deformity always suggests itself; at the very beginning, when correct treatment is of the greatest importance, this is not the case, and we often must recognize a slight deviation from the normal, a minor projection, etc., and often the position assumed by the patient suggests this, as for instance, the forward curve when the arms are raised, in case of skoliosis.

Occasionally, orthopedic affections only cause functional disturbances, and in these instances examination under anesthesia often first teaches us the degree of the diminished mobility, etc., as, for instance, in case of contractures.

It is highly important in many cases, for comparative purposes, to carefully measure the deformity and to make a schematic drawing of it.

The ordinary tape-measure answers the first indication, and the second is fulfilled by the plaster cast, by photography, by the direct tracing of the contours.

In case of many deformities it suffices to measure the angle which the joint abnormally forms, and for this purpose, in addition to the ordinary square, the goniometers are useful. I may mention the goniometer of Morisani,[8] Krohne, Paci,[9] Gutsch.[10] I will only figure the Roberts' instrument.

In many cases it is essential to take the measurements at

different levels (the sagittal, vertical, and frontal), and for this purpose complicated instruments are necessary. Among others Roberts [11] has made use of geometry for the description of deformities, terming the method *diastrophometry.* A number of useful instruments have been devised for the purpose of measurement.

In Roberts' Goniometer (Fig. 3) both arms may be used and made so short that the angle of a kyphosis may be determined. Pelvic obliquity, abduction or adduction, flexion or ex-

Fig. 3.—Roberts' Goniometer.

tension, in short any deformity at any level may be measured by this instrument.

For the determination of deformities at different levels Robert's epipedometer (Fig. 4), which may be placed at any angle, is useful.

The two arms of the instrument, at right angles to one another, may be fitted to any surface of the body, and the deviations of the arms are carefully registered in degrees; one arm may readily be shortened, so that the instrument is also of utility in the measurement of club-foot.

Instruments of this nature are especially applicable to skoliosis, and many are nowadays constructed.

To obtain the configuration at any level an ordinary strip of lead will suffice. The lead-curve thus obtained may be transferred to paper.

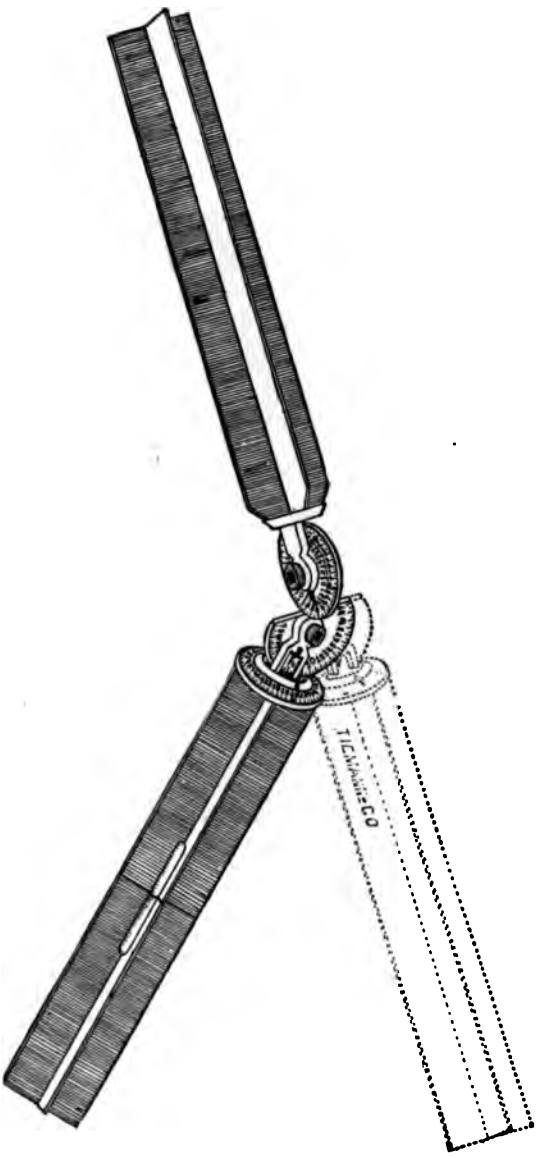


Fig. 4.—Roberts' Epipedometer.

To measure the thorax the kyrtometer is useful, as also analogous instruments constructed like hat machines. To register simple cross-sections, the apparatus of Stark [12] (a double-circle with pencils at each extremity), that of Schenk and others may be resorted to. In many instances of deformity of the foot it is advisable to obtain an outline of the plantar surface a pelmatogram (πελμα, sole). The patient is made to tread with blackened foot on a sheet of paper and thus a picture of the sole is obtained; the patient can be caused to walk on the paper and thus

his manner of placing his foot down when walking is obtained (an ichnogram or stibogram). The value of this method has been particularly emphasized by F. L. Neugebauer,[13] Vierordt and others.

The prognosis of deformities, in general, may be considered good when no severe general disease is at the bottom, and when we are not dealing with a defect in formation of the bony parts, as in skoliosis. By means of bandages and apparatus, and particularly by the modern operations, the surgeon is able to obtain complete cure, or essential betterment, in a relatively large number of cases. Even in case of curvatures not specially accessible to therapeutic methods, such as skoliosis, the prognosis has become much more favorable when the cases come early under treatment, for then we frequently obtain betterment, or at least check the progress of the affection.

We would note specially here that only in case of a few deformities does spontaneous cure occur, as in the slighter degree of rachitic curvatures; in by far the larger majority of instances, the deformities are progressive, and it is a mistake to tell the relatives that in the course of growth the deformity will alter for the better, for thus the most profitable time for treatment is allowed to pass.

In connection with therapeusis we must lay stress on prophylaxis, the entire aim being to cause the body and brain to develop simultaneously, to further by all means the *mens sana in corpore sano.* Under this head are included not alone the proper food and clothing in childhood, in brief, attention to every detail of hygiene, but also suitable hardening of the bony and of the muscular system. Gymnastics, swimming, riding, out-door exercise and work, etc., these may do much to prevent the development of many deformities. In how far this bodily exercise may favorably affect the race, ancient Greece with her Olympic games is a witness, and I recommend, in particular, gymnastics after Busch's[14] description.

In this connection it is a cause of congratulation that the chief sports in England (ball playing, rowing, etc.) are obtaining a greater foothold with us. Another important factor for the prevention of deformities lies in the spreading of the knowledge of how to treat diseases of the joints properly. It is essential that the inflamed joint should be placed in such a

position that, if anchylosis ensue, it may be most useful (that is, hip and knee well straightened out, foot and elbow bent at right angles); further, it is important to resort in time to passive motion, manipulations and massage, as soon as the essential inflammatory symptoms have disappeared.

Most frequently it is the congenital deformities which reach a high grade, since the parents of the sufferer, from stupidity or ignorance, do not seek the requisite treatment early, and herein lies the great value of state institutions such as Stromeyer and Dieffenbach argued for and Lorenz has latterly recommended. "What good end would not a state institution fulfill where all the crippled children of the land could resort, and if possible be cured,—" thus speaks Lorenz, and indeed such institutions would be of far greater value than the offering for sale of faulty orthopedic apparatus.

As regards the appropriate treatment of deformities, we may in general range ourselves on Seneca's side when he says: "Sanabilimus ægrotomas malis ipsaque nos in rectum genitos natura si emendari velimus, juvat," the majority of orthopedic troubles being curable or subject to betterment, and in many cases by means of the simplest appliances.

No single scheme of treatment, however, is applicable here, no single method but a combination of many methods usually fulfills our aim; we must not alone depend on mechanical means but also resort to dynamic, and among the former must be classed gymnastics, "orthopedic-gymnastics," as Delpech termed them.

In orthopedics we must, in particular, individualize, for each case has its own special indications which must be attended to; a method which in one case seems suitable, in another will not be appropriate. In any event, the general state of the patient must be considered.

To mention now the most essential orthopedic methods of treatment, we have: 1. The constitutional, general treatment, which includes: *a.* Attention to hygiene; *b.* Medicinal agents; *c.* Physical agents (gymnastics, massage, heat, etc.); *d.* Electricity.

2. Mechanical agents (bandages, orthopedic apparatus); and finally,

3. Orthopedic operations (either requiring the knife or not).

The error was formerly made of considering the constitu-

tional treatment the chief one, and to-day actually this principle obtains to far too great a degree. There can be no question that attention to the general rules of health, the obtaining of fresh air, care of the skin by baths, etc., strengthening food (breast milk for young infants), will effect much, and that in orthopedic hospitals the good results obtained are in part to be laid to the application of hygienic principles; still these health-rules will not alone suffice, except in very rare cases where they are associated with the strengthening action of sea air, as at the sanitariums at Norderney, Sylt, Margate, Ramsgate, Eastbourne, Bec-sur-mer, Trouville, etc. Of medicinal agents of value the chief are iron, preparations of quinine, cod-liver oil. In rachitis the phosphates and sulphates are especially useful at an early stage to replace the lack of bone salts. To-day, owing to the researches of Kassowitz and of Wegner,[15] we must grant considerable value to phosphorus in the treatment of rachitis.

In case of 500 rachitic children Kassowitz witnessed the most marked results from the administration of phosphorus, and Unruh, Th. Toeplitz[16] and others have confirmed these results. Kassowitz recommends a daily dose of $\frac{1}{13}$ of a grain in mucilage or in cod-liver oil.

℞ Ol. Morrhuæ, ... ℥ iij ʒ ijss.
Phosphor., ... gr. $\frac{1}{65}$.

Or in an emulsion as follows:

℞ Phosphor., ... gr. $\frac{1}{65}$.
Solve in Ol. Amygd. dulc. ʒ ijss et adde
Pulv. acaceæ,
Syr. simpl., ... āā ʒ j gr. xv.
Aq. destil., ... ℥ ij ʒ v.
M. S.—One to four teaspoonfuls daily.

Latterly, Lesser has recommended the following as an antirachitic mixture:

℞ Tr. rhei vinos., ... 20 parts.
Potass. acet. sol., ... 10 "
Vini stibiat., ... 5 "
M. S.—According to the age of the child administer from five to ten drops three times daily. Increase the dose every third day by one drop until the child receives from twenty-five to thirty drops three times daily.

In addition to the above remedies, in cases of paralysis, strychnia may be ordered in the dose of $\frac{1}{65}$ of a grain three times each day, or else it may be administered subcutaneously in the dose of $\frac{1}{20}$ of a grain once a week, this dose being increased according to circumstances.

Of the general physical therapeutic agents, we note: heat in the form of the sun-baths, warm baths and douches, the use of the vapor bath to equalize the circulation. In paralytic cases and in chronic joint affections, the peat and salt baths, dry heat as recommended by Beard, of New York, may be used and the latter may be applied by means of Leiter's coil. Hot poultices, protected by gutta-percha paper, will often be found useful.

A method which has been enthusiastically claimed as the only true and efficient one in orthopedics and again has been rejected as simple humbug, is gymnastics, that is to say the methodical exercise, active and passive, of the muscles. There is no question that this method, carefully and continuously

FIG. 5.

used, aside from its general strengthening effect, is valuable in the treatment of many orthopedic affections, especially where we aim at exciting and restoring function in certain groups of muscles. Of special value is the method devised by the Swede, P. H. Ling (died in 1839), and amplified by a number of others (Bronting, Rottstein, Norman Roth,[17] etc.), the method of so-called "Swedish gymnastics," whereby not only active and passive movements are utilized but also a general effect on the muscle functions is exerted. This method has many adherents, and it is applied in a number of institutions, such as those at London, Stockholm, Baden-Baden, etc.

The most essential point about the Swedish gymnastics is the methodical movements to which the individual is subjected. Either the operator endeavors to overcome opposition on the part of the patient, or the latter on the part of the former.

Apparatus for these passive movements may also be used.[18] Especially useful are the so-called thoracic joint-strengtheners (Largiadèr[19]), the restorator (Goodyear), which is seen in Figure 5.

The restorator[20] is especially useful for the methodical exercise of muscles, for owing to the necessity of stretching the rubber band, the patient may himself take account of his muscular power (Vogt, Weil.[21]). The same is true of other apparatus, such as those devised by Sachs, by Seeger, and others.

Massage (from μασσειν, to rub) was used by the ancients, the Indians and other races,[22] for therapeutic purposes; its utility has lately been exposed by Metzger (Amsterdam), Mosengeil, and others, and the results obtained have led to its wide dissemination.

Massage consists in rubbing, pressing, striking, etc., a portion of the body. It increases the force of the circulation, it causes a more rapid absorption of the products of inflammation; under the influence of massage partial stiffness of joints disappears, atrophic muscles become richer in blood and stronger, in short the nutrition is improved, and the retrogressive phenomena occur to better advantage in the parts subjected to the manipulation. In particular has Mosengeil[23] utilized the various manipulations (*effleurage* or centripetal stroking by flat hands, frictions, ellipsoid rubbings with the finger tips, *pétrissage* or kneading of the affected part, *tapottement*). These various manipulations have become popular, and latterly, works on massage have appeared in which the technique is carefully described,[24] and instruments have been devised to take the place of the masseur's hands (such as the elastic muscle-beater of Klemm, or that devised by Flasher[25] which is constructed of wood).

The effect of these methods is due rather to the rubbing than to the materials which are rubbed in, such as vaseline, borax ointment, olive oil.

In this connection we must refer also to passive movements, the so-called manipulations, the rotatory motions in the direction opposed to the deformity, which are applicable especially to club-foot, being repeated frequently during the day, the foot being redressed and held in such position for awhile in a suitable apparatus.

In this way the ligaments and bones are prevented from developing abnormally, for the deformity increases with growth, and thus the obstacles to redressement are lessened without the motion of the affected part suffering. Generally, other methods, such as holding the affected part for a long

time in as good a position as is possible, will effectually assist.

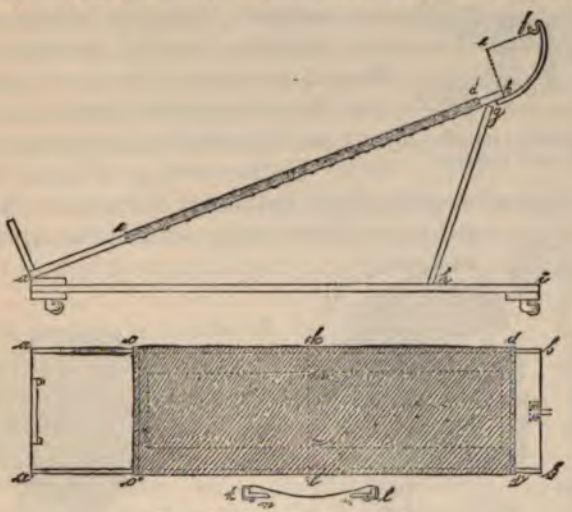
As regards the applications of electricity in orthopedics, the faradic, and more frequently the constant, current may be used over single muscle groups, but the current must not be too strong, or of too protracted duration (five to fifteen minutes once or twice daily). Sayre lays stress on the point that, when a paralyzed muscle is galvanized, it must be placed in such a position as to be subject to no strain of any kind whatsoever.

The action of the current is all the stronger when it is applied to the spot where the most effective motor branch enters the muscle. Duchenne, of Boulogne, and v. Ziemssen[26] have considered at length the preferable points of application, and for such information I must refer to their valuable works.

In exceptional cases galvano-puncture of the muscles will prove effective, that is to say, the passage of the current through the muscle, by means of a needle connected with an electrode and inserted into the muscle while the other electrode is placed on the surface of the skin.

We now pass to the description of the simplest mechanical appliances, the position and fixation apparatus. The former plays an important rôle, especially in the treatment of disease of the spinal column, and it may answer the purpose of affording rest to the entire body, or else of only a portion of the body (as for instance Eulenburg's[27] scoliosis apparatus, and the devices of Bonnet, Mayer, Rauchfuss, and others). For the sitting posture, the Volkmann-Barwell's oblique seat is to be commended (for skoliosis). We may mention here, also, the numerous orthopedic beds, as those of Valerius Venel, Guérin, Bouvier, Pravaz, Boynton, Harrison, Heine, etc. The majority of these beds are supplied with extension and counter-extension mechanism. Such apparatus will be spoken of under the heading of mechanism for reduction. As an example, we will describe here the Beely extension bed for skoliosis, which is seen in profile in Figures 6 and 7. *hg* answers the purpose of elevation to the desired extent; *bf* is for the attachment of the girdle; *f* is a roller over which the weight is suspended; *cd* is the linen covering of the surface *ad*. In Fig. 8 the girdles are seen which pass under the chin, back of the neck and under the axillæ.

Other beds are provided with mechanism for lateral inclination, such as Delpech's, H. Bigg's, and girdles may also be fitted to them. In the Bürings[28] apparatus for skoliosis, pads worked by screws assist in reduction. The same holds true of



FIGS. 6 and 7.—The Beely Bed.

Hüter's modification of this apparatus, and of Loring's, which is used in hip contractures, etc.

I can all the more readily pass over these apparatuses since most of them are only of historical interest and have latterly been described by E. Fischer,[29] and I may dismiss from consideration the orthopedic chairs, etc., for they are no longer in use.

FIG. 8.—Girdle of Beely's Bed.

I will mention the so-called mechanical beds and the beds fitted with apparatus for lifting the patient. The first allow of defecation and of change of the bed-clothing without specially disturbing the patient, and this is accomplished either by sliding a board with an opening in it under the patient, as in the R. Volkmann bed,[30] or by an extension mechanism,[31] as in the Lücke bed; or further still by mechanism by means of which the mattress sinks down and may be removed, as in the Crosby bed. Of the

apparatus for lifting the patient, the best is Beck's, since it is contrived so that the whole body of the patient or an individual portion, may be lifted.

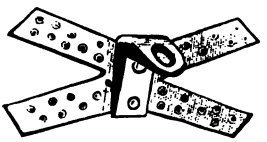


FIG. 9.—Hook for Insertion in a Plaster of Paris Bandage.

We pass now to the consideration of the various orthopedic bandages which are intended, usually, to maintain a deformed portion of the body in position and thereby lead to better appearance, or possibly, only to betterment in function. The importance of these bandages is all the greater, seeing that by means of them we can, in the cheapest and quickest manner, apply suitable treatment, and

FIG. 10 a.—Roberts' Elastic Tension Corset with Jury-mast.

FIG. 10 b.—Roberts' Plaster Bandage with Extension and Elastic Traction Apparatus.

in that the physician may combine with them a number of other adjuvant therapeutic means (such as extension, elastic traction, pressure, etc.). They are generally useful, in par-

ticular in dispensary practice, where they most frequently answer the indications.

The plaster bandage with justice leads the others, and it is best prepared from large-meshed gauze rubbed in finely pulverized modeller's plaster. The plaster, when it has hardened, answers the purpose of holding the bandage in place. To strengthen it in various places it is advisable to fit in here and there pieces of wire or corset-steels, etc., or pieces of linen dipped in plaster may be inserted in the bandage as it is being applied.

It is often essential in laying the bandage to insert splints to maintain redressement, and these keep the parts in position during the setting of the bandage.

In children it is advisable to varnish the bandage after it has hardened to prevent its becoming wet through by urine, etc.

By sinking hooks or brackets into the plaster we obtain points for attachment of extension or traction apparatus, as is seen in Heine's[32] extension-splint. In Fig. 11 a simple apparatus of this nature, made by Reynders, is seen. The arm *D* is moved by the long screw *C* by means of the key *G* and is fastened at *E*. The ends are inserted into zinc plates which are fitted into the plaster bandage. The splints of this nature devised by Beely,[33] of the Königsberg Clinic, are especially useful in orthopedics, particularly where the lower extremities are concerned.

Fig. 11.—Extension Splint.

We may note here the Robert's plaster corset with extension blades sunk in, the length and force of which are regulated by the screws.

The bandage made from plaster with the addition of coal dust has the advantage of being lighter, of setting more quickly, and of resisting moisture better, and was recommended by the workers in Langenbeck's clinic. The paraffine bandage has been warmly indorsed by many, Whitson for example, owing to the lesser danger of decubitus resulting.

The silicate of soda bandage has, in general, the advantage of lasting longer and being less heavy, but its disadvantage is the fact that it requires more time for hardening; in ortho-

pedics, still, it is advantageously used for making corsets,[34] etc., but the precaution must be taken not to moisten the first turns of the bandage too thoroughly, else the lower surface will become impregnated and be rough.

In order to overcome the objection to the silicate bandage that it requires too long an interval for hardening, an oiled-paper may be laid over it, and next a few plaster layers which may be removed in a few days after the silicate has hardened. (Wolff, Fowler, etc.) The silicate bandage is as appropriate for the lower extremities as for spinal corsets. König uses, with good result, a mixture of magnesite and silicate of soda; such bandages are readily worn and are not likely to be broken or wet through.

Fig. 12—Orthopedic Plastic Felt Apparatus. (Beely.)

Paste-board bandages are also used, and are recommended especially on account of their slight weight, and they may be made very solid and lasting by the insertion of splints, etc.

Plastic felt impregnated with hair (presented by Cocking in 1870, and first used by Ernest Adams) has quickly obtained a foothold in orthopedic surgery. It may be readily shaped by dipping in hot water; Beely[35] has used it after impregnation with an alcoholic solution of shellac. It may be modelled over a plaster cast of the part where it is to be applied, and it may be loosened or tightened, according to desire, when in place (Schwartz[36]).

We will now speak of the methods of preparing casts from plaster of Paris over which the plastic felt may be modelled. Over the oiled surface Beely places a plain, lightly applied, plaster bandage, and this is cut and removed as soon as it has hardened. The interior of this cast may then be filled with plaster and the desired model is obtained. That the model

may not be too heavy a tube may be inserted through the centre.

For the preparation of casts of the back certain modifications have been introduced. Braatz[87] makes a light cast by covering the inner surface of a linen model with an inch or so of plaster; after the removal of the covering the plaster cast is smoothed down and the felt is fitted over it.

Karewski[88] quickly lays a plaster bandage around the sus-

FIG. 13 a.—Patient before Adaptation of Corset.

FIG. 13 b.—The Corset with Suspension Bands.

FIG. 13 c.—Patient Suspended with Corset in Place, prepared for Covering with Plaster.

pended patient, inserts the hooks while the plaster is soft, cuts the corset when the plaster has hardened, smooths the edges, and then oils the model and rubs plaster over it.

In Figs. 13, a, b, and c is represented Heidenrick's[89] method of obtaining a cast. He suspends the patient and places around him a sack made of coarse linen, brought together above with a running string, packed with cotton below and made fast above the trochanters. On each side of the oiled

body extending over the shoulders is a string which serves the purpose of cutting the plaster cast, before it has hardened too much, into two pieces exactly adapted to one another.

In Fig. 12 Beely's [40] method of using felt is shown.

Leather has also been utilized for corsets, etc., and owing to its durability and elegance its application is a wide one, Beely used stout leather hardened in glue, and by painting it over with double potassio-chromic acid he makes it very resistant to moisture. Karewski [41] and I. Smith recommended fine wire gauze for orthopedic bandages, and this has the advantage of being light and permeable to the air. In exceptional cases hard rubber, softened in hot water, will prove useful; when heated it may be readily bent to any desired shape and retains it when hard.

Another material often used in orthopedic surgery is diachylon plaster, and this leads us to speak of the traction bandages which are resorted to to prevent contractures, to assist growth in a desired direction, etc.

This plaster is most frequently used for the redressement of slight deformities of the feet, etc., generally in connection with splints, etc., and for orthopedic purposes it must, of course, be not too yielding, and be possessed of good adhesive properties. Maw's moleskin plaster is a good article. Before the application of the plaster the surface must be washed off with soap and thoroughly dried. If necessary it must be shaved. In case of extension bandages, which are chiefly used for the lower extremities, the Volkmann method of plaster and foot-piece has obtained wide acceptance. In addition to the quality of the plaster, care must be taken to pad the tibia and the projecting bones of the ankle, lest decubitus ensue.

In the majority of cases, extension may be obtained by stones or sand-bags slung over a roller, while the counter-extension is yielded by the weight of the body. Rarely are inclined planes requisite for counter-extension.

When extension is made from the head, it is obtained by leather bands (*a* and *b*) encircling the chin and occiput, which are united each side under the ears by buckles (*c*), and are suspended from above by slings attached to rings (*vide* Figs. 14 and 15).

A simpler method is, after shaving the head, to use strips of plaster under the chin and occiput, extending them over the

ears to the level of a tangent across the sinciput and here to attach them to a hook by means of a third sling of plaster.

To obtain horizontal extension there are a number of appliances applicable to skoliosis, torticollis, etc., which will be spoken of under the subject of curvature of the spine.

We find the principle of vertical extension in ancient orthopedic apparatus, such as the Bloemer chairs, the Shaw sling, and these are not only useful in case of disease of the spinal column, torticollis, etc., but also in cases of curvature of the limbs.[42] Thus, the vertical apparatus recommended by Schede and others, for fracture of the thigh in children, may be utilized in case of aggravated rachitic curvature of the femur.

Fig. 14.—Head-Sling. (Beely.)

In simple suspension, that is to say in the lifting of the body from the sitting or standing posture (as may be accomplished by Glisson's slings, axilla slings, Beely's self-suspension apparatus, Fig. 16,) Sayre's tripod, which may readily be

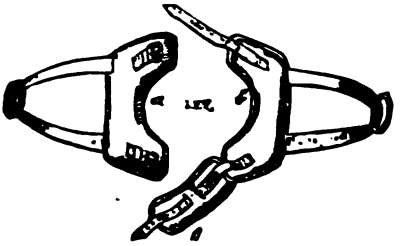


Fig. 15.—Head-Girdle in two parts.

improvised, is useful. The body-weight acts as counter-extension; occasionally we may, in addition, obtain a species of lever effect by causing the patient to bend over a line (Vogt[43]).

Orthopedic apparatus should not only be cheap, lasting, and readily applied, but in the majority of cases it should be carefully supervised. As Noble Smith says, "No instrument will be of much use unless the surgeon devote his attention to its adjustment and re-adjustment"; and as Hennequin[44] says, "Un appareil quelqu'il soit ne vaut que par celui qui l'applique." It is not so much the apparatus as the manner of

its application which makes it efficient, and badly applied it will work harm.

As to orthopedic apparatus in general the simplest is the best.[45] In many cases, where formerly apparatus was necessary, we can to-day dispense with it in favor of operative procedures, etc. Much always depends on the exact application of apparatus, and this is the reason why the aid of an expert orthopedist must, in special cases, be invoked.

FIG. 16.—Beely's Apparatus for Self-suspension.

FIG. 17.—Suspension Apparatus.

We may divide the apparatus into: 1. Retention means; 2. Reduction means, by which curved or deformed parts are restored to the normal position by traction or pressure; 3. Ambulant apparatus.

In general, orthopedic apparatus may be divided into ambulant, that is, that which may be worn by the patient while about, and into apparatus which can only be used with the patient in bed.

The materials out of which the apparatus may be constructed are steel, iron, wood, leather, hard rubber combined with elastic straps, etc. The most durable and elegant splints are those constructed of leather fashioned over wood or plaster models, connected together by steel blades and straps, and with movable joints. These are light, and therefore particularly advantageous when, as in case of paralyses, etc., they must be worn for a long time. In regard to the nature of the joints, the hinge, as we find it in any pocket-knife, is the most frequently resorted to. Less frequently the joint is constructed similarly to the hinge of a door, the motion being at the level of the surface of the splint (as in Bonnet's apparatus for the prevention of inward rotation of the foot, where the pelvic gir-

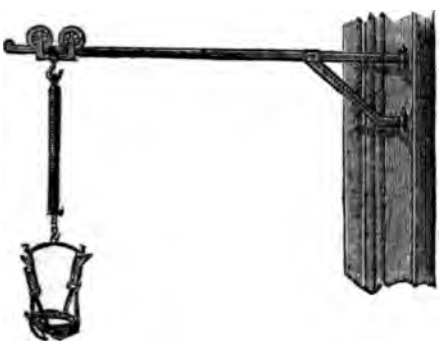


FIG 18.—Extension Projection of Iron Fastened to a Door. The suspension portion moves on rollers.

dle and the splint for the upper leg are so connected. This is shown in Fig. 29).

Where it is essential to obtain motion in a number of directions, a variety of joints are combined. By the combination of three, Stillman, for instance, has devised a universal joint, thus obtaining all the advantages of the ball and socket joint (free motion in all directions), without the disadvantage of being obliged to entirely fix the joint or else to allow of motion in any direction.

The enarthrosis, or ball and socket joint, is less frequently used, as it is found in certain apparatus devised for torticollis (Bruns), in a number of club-footed appliances (Busch), in apparatus for congenital luxation of the hips (Nyrop), etc.

The joints are rarely entirely uncontrolled, for they are in-

tended to guide, as it were, the movements of the part of the body concerned, to control the motion of the limb in a certain direction; in the knee, for instance, to prevent lateral movements; usually the object is to allow motion only to a certain degree, or to prevent motion in a special direction.

With this end in view counter-checks are inserted in the joints to prevent undue movement in the direction opposite to that which is desired.

On the other hand, it is often essential to prevent motion only to a certain degree for a special purpose, that is to say, to be able to limit motion, and for this purpose screws answer best. By means of screws the two sections of the apparatus may be joined together at any desired angle.

Fig. 19.—Nyrop's Machine for Paralysis of the Lower Extremity.

A very practical application of this point we find in the Stillman sector splint among others, where one splint may be placed at any angle to the other and is held in position by a screw.

Where the aim is to secure position in a special direction, as in extension, then a simple bracket or bolt-like mechanism is the readiest, as is exemplified in the apparatus for keeping the knee extended, where a small steel arm, projecting from one splint, fits into a circular piece on the other splint.

Fastening may be accomplished in a very simple manner by means of clasps, fitting the one into the other, attached to the sections of the splint—as in the Nyrop apparatus for paralysis of the extremities, a contrivance which is all the more valuable practically in that by slight pressure on a circle (*D* in Fig. 19) the apparatus may be quickly set out of function.

Where fixation in very different directions is essential, we may insert a small spring which fits into a toothed wheel, as in the Baedenheuer shoe for club-foot, etc.

In the ambulant apparatus for the lower extremities, the mechanism is ordinarily fitted into the shoe, the two blades of the splint being united between the inner and outer sole of the shoe, or, in order to be able to separate the blades, they are

inserted into projections at right angles to the shoe or firmly bound to them by a clasp spring.

Where we are not obliged to take the question of cost into consideration, it is preferable, from the stand-point of durability of the apparatus, to fit a well-padded metal sole on the shoe, so that the apparatus may be worn independently of the shoe, that is even with slippers.

The orthopedic shoe is of special importance. Often, by making the sole of one shoe higher than that of the other, or by the addition of an extra section of leather to the sole, we may counteract an abnormal position of the foot, or by building up one side of the shoe we may oppose a curvature. These points are exemplified in the Kolbe club-foot shoe, and in others. By a very simple contrivance the patient can be compelled to place his foot down in a special manner, as is exemplified in the mechanism in the Roser stirrup shoe, where a metal stirrup projects laterally from the surface of the shoe. Occasionally a rubber sole is to be commended, owing to its durability and pliability, the latter quality allowing any desired shape.

In order to make locomotion easy and in order to secure certainty of adaptability of the foot to the shoe, it is advisable to have it laced all the way up in front above the ankle joint. Thus the foot is thoroughly secured.

A large majority of the ambulant apparatuses are attached at the pelvis and for this purpose a well-padded girdle is necessary. This may be made of sheet iron and in front of leather. In many instruments steel bands, padded, pass over the crests (Langgaard) and are attached to the pelvic band.

Where it is particularly desired to fix the apparatus to the pelvis we may use corsets, as is the case in various French appliances. These may surround the hips, sacrum, or the entire lower abdomen and back, and the special apparatus may be attached to the corset by steel clasps or by leather straps. Again, as in the Nyrop corset for inferior lumbar kyphosis, a pad may be placed over the nates behind the trochanters and be attached to the corset.

Further, dorsal splints, with head supports, etc., may be adapted to the pelvic bands and these may be fitted into an orthopedic corset.

Other important orthopedic apparatus is seen in the reduc-

tion machines, which we may divide into ambulant and non-ambulant, and in the construction of which we find the most varied mechanism. In case of the non-ambulant apparatus, we deal with extension mechanism by weight, bands, etc., either in one direction—as in Stromeyer's equinus apparatus (Fig. 20), the Lorinser-Bonnet knee contracture apparatus—or in two opposed directions, as in various extension beds (Heather Bigg's, Fig. 23, Heine's, and others) which will be spoken of in detail under the subject of diseases of the spinal column.

The ambulant apparatus is to-day used with far greater frequency, and here the principle of the lever (one-armed or two-armed) may be utilized, as in the apparatus adapted to

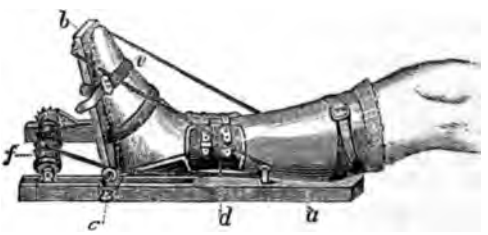


FIG. 20.—Stromeyer's Equinus Apparatus.

genu valgum, contractures, club-foot, etc., in the shape of different lever splints.

A very efficient means of reduction is offered by elastic traction, whereby we may obtain a continuous, slight, graduated force, or, if desired, a very great force (Barwell, Bruns), and we may use for this purpose either material with rubber set in (as in the Barwell skoliosis bandage, the Fischer bandage for skoliosis), or else rubber bands (as in the various contracture apparatus), or rubber rings which are placed between two straps, and the force exerted by which we may graduate by means of the straps. Elastic traction is exerted in many of the recently devised orthopedic appliances, such as the ingenious apparatus of Blanc, the club-foot apparatus of Sayre, Stillman, and others, and this traction is all the more to be recommended since it may readily be combined with plaster-bandages, or any material which it is desired to use. Thus, elastic traction is resorted to in rotation of the foot, by connecting the lateral bars of the splint with elastic bands (Beely).

Among these appliances with elastic traction are included those where groups of muscles are re-enforced by the tension in order to antagonize other groups. Delacroix, Duchenne and others have commended such appliances, of which number we will only refer here to Delacroix's apparatus for paralysis of the extensors of the fingers, and to the apparatus for use in paralytic pes equinus and pes calcaneus, where the paralyzed muscles are re-enforced by elastic bands or rings.

Spiral metallic springs may also be used for traction purposes, as is exemplified in Heather Bigg's extension bed (Fig.

Fig. 21.—Lücke's Apparatus for Club-foot.

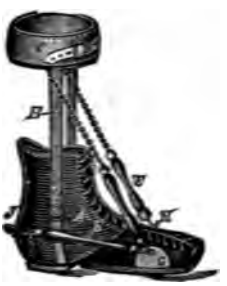


Fig. 22.—Sayre's Shoe.

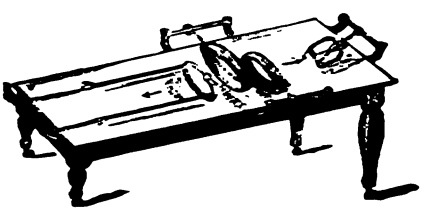


Fig. 23.—Bigg's Extension Bed.

23), and the spring may also be utilized for obtaining rotation, as in Doyle's apparatus for the after treatment of club-foot.

In case of paralysis, these spiral springs are also resorted to, as in Mathieu's apparatus for paralysis of the quadriceps femoris, where the thigh and the leg splints are connected together in front by a spiral spring. Springs are also adapted to many appliances for pes equinus, pes calcaneus, and to Duchenne's apparatus for paralysis of the muscles of the foot, where small springs, corresponding to the paralyzed muscles, are inserted into the leather.

These springs are also useful to keep two portions of a bandage apart and to obtain extension, as in the Roberts corset (Figs. 10, 25.).

In spring steel splints we also have a valuable means of reduction, and they may be used either to exert traction or pressure. In the first instance, they may be parabolic in shape or S-shaped. These springs are used in the numerous club-foot shoes (as in Scarpa's shoe and its many modifications), the band fastened to the leg keeping the foot pronated and abducted. The S-shaped band exerts not only extension but also sub-luxation backward, as is exemplified in many pes equinus, and in many contracture appliances (Heather Bigg's knee apparatus, for instance).

Fig. 24.—Doyle's Apparatus.

Resort to metal bands for the purpose of exerting pressure we see in connection with pressure cushions, and Nyrop's skoliosis apparatus may be taken as the type. In this apparatus the vertical dorsal blades are held backward by elastic steel bands, and at the point where these are brought forward to be fastened they exert pressure on the cushion, that is, directly against the angles of the ribs, while the remaining blades exert no pressure at all on the body.

The toothed-wheel and toothed-bar are utilized in many orthopedic appliances for effecting reduction where we aim at considerable gradual extension by the apparatus. The toothed bar is also used with a surrounding metal spring, and this en-

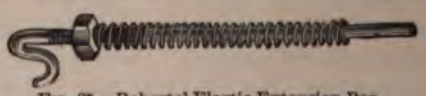


Fig. 25.—Roberts' Elastic Extension Bar.

ables us to obtain fixation in a better position, and prevents return to a faulty one. This is exemplified in the Roeser-Baedenheuer club-foot shoe.

Formerly the screw mechanism played a great rôle in or-

thopedics, and this is not surprising, for, before the introduction of elastic traction, by means of the screw gradual and

FIG. 26 a.—Nyrop's Spring Splint.

FIG. 26 b.—Beely's Corset.

great power could be obtained according to the desire of the surgeon.

FIG. 27.—Reynder's Apparatus for Torticollis.

FIG. 28.—Kolbe's Club-foot Apparatus.

The most popular was the endless or Archimedes' screw, and this was utilized in many contrivances for contracture of the extremities.

While the simple endless screw is seen in many contracture appliances, such as the Ulrich and Mittler's hip-extension apparatus, the Langgaard knee-extension apparatus, the H. Bigg and the Goldschmidt's finger-extension apparatus, we also find the manifold endless screw utilized for the purpose of effecting reduction, as in club-foot appliances (Charrière, etc.), skoliosis contrivances (Langgaard, Eulenburg), torticollis apparatus (Fig. 27), Stillman's and H. Bigg's machines, for antero-posterior curvature of the spine, contrivances which naturally act the more effectively, the longer the lever arms which are adapted to them.

The screw mechanism is also utilized at the angle between two articulated splints, so that the distance between them can be lengthened at will by the screw. This is the case in Kolbe's elbow machine and in a number of club-foot appliances, etc.

Fig. 29.—Screw in Bonnet's Apparatus.

Fig. 30.—Bonnet's Machine for the Exercise of the Talo-tarsal Joint.

The *vis a pression*, which Guérin formerly used to a great extent, has to-day much less recognition. A simple screw passes through a stationary nut and presses on the movable arm of a lever, forcing down this end or preventing its elevation, so that excess of movement is impossible. This form of screw is seen in many club-foot apparatuses (Lutter's and Langenbeck's), the aim being to prevent the equinus position, and also in Bonnet's machine for the prevention of inward rotation (Fig. 29).

A further group of appliances are the self-movable machines, many of them ingenious and devised by Bonnet, by means of which the patient may himself exercise the functions of a joint by exerting passive motion, usually through a cord passing over a roller, on which the patient makes traction.

These machines allow of motion only in one level (the best known is Bonnet's appliance for knee-contracture), and in

order to apply passive motion to the foot, for instance, three machines are necessary and therefore apparatus of this nature

FIG. 31.—Apparatus for Movement of the Talo-crural Joint.

has yielded in general to movements applied through the hands.

In this place belong the appliances in which, by changing an elastic band from one to the other side, the movability of

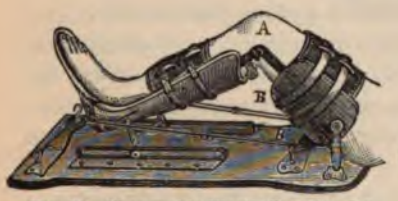


FIG. 32.—Changeable Elastic Traction for Correction of Knee Contractures. (Collin.)

FIG. 33.—Changeable Elastic Traction for Correction of Knee Contractures. (Collin.)

a joint is increased (as in the Collin, and the Reibmayer contracture apparatuses).

SURGICAL ORTHOPEDIC OPERATIONS.

Surgical operations also play a most important rôle in orthopedics and in this respect has progress in modern times been most marked. The operations are: 1. Special manual, without injury to the skin, and, 2. Cutting procedures, and these may be either subcutaneous or percutaneous. It is evident why, at a time when, by any cutting method, there existed danger of abscess, suppuration, septicemia and pyemia, the subcutaneous method, owing to the slighter risk of wound complication, should have been preferred; to-day, however, owing to the aseptic methods of treating wounds, the open operations are growing more in favor. We need mention only the open myotomy of the sterno-cleido-mastoid, the Phelps operation for club-foot, etc.

We may further divide operations into those which are limited to the soft parts and into those which concern the bones; in both, however, it is essential that the after-treatment should be the correct one.

As regards the special manual operations without injury to the skin, they are intimately related to massage manipulations, extension by bandages, etc., of which we have already spoken.

When the insertion points of muscles become so approximated as to lead to deformity, the manual stretching of the muscles, with or without anesthesia, may be resorted to in order to overcome this deformity. Manual manipulations are oftener called for on account of inflammatory adhesions, etc., in or near a joint, and we will speak further of the method of *brisement forcé* under the subject of contractures; in general, the force used should not be too great lest rupture ensue.

If, by such methods, the malformation be corrected, then it becomes necessary to hold the part in good position by means of bandages, or else, through passive motion, to recover the normal movability and thereby to restore function to the limb.

In connection with the osseous system also, methods unassociated with injury to the skin are called for, and owing to the greater accuracy of the modern apparatus for osteoclasis, that is, the breaking of deformed bones by weight without the making of a wound, this method excels osteotomy. Usually osteoclasis is performed by lever action, either by the hand of the operator alone, or else with the assistance of special apparatus (osteoclasts), as a rule, under anesthesia. The hand is suitable especially in case of long, non-sclerosed bones. Many curvatures of the bones in infants, due to rachitis, provided sclerosis has not set in, may be bent straight with almost no force; the same holds true for badly united fractures before the callus has hardened. We work in these instances with both hands on each side of the eminence of the curvature, the thumbs being placed at the site of greatest curvature, and we may thus readily straighten the bone; we usually feel crepitus resulting from slight fracture, but this heals quickly under a fixation bandage. The English writers compare this fracture to the variety known as "green-stick."

Where rachitis with sclerosis has occurred, and this may

happen as early as two to four years, then the strongest man is not able to break the bone of a child, and here osteotomy finds its indication. In case of adults, only exceptionally is it possible to break a deformed bone manually (especially, for example, in case of badly united fractures of the fore-arm). Ordinarily, a large hollow bone may be broken by bending it over the knee or the edge of a table, etc., these points acting as resistances to the lever action, and when the bone is too short it may be lengthened by plastering on a splint.[46] Usually large arc-like curvatures, where sclerosis has not set in, yield best to such methods.

In the majority of instances in adults the requisite force must be obtained through special instruments, and here the chief difficulty is to obtain the fracture at the desired place. While, formerly, forcible extension by the Schneider-Mennel apparatus, etc., was the practice, to-day the ostecolasts are substituted, especially the improved ones of modern times.

Fig. 34.—Rizzoli's Osteoclast.

With the majority of osteoclasts the portion to be operated upon rests on a hard surface, and at the site of greatest curvature force is exerted through a pad, etc., and thus the bone is fractured. The simplest instrument of this nature is that of Bosch,[47] which acts on the principle of the book-binder's press. Of the numerous osteoclasts (or dysmorphosteopalinclasts) those of Blasius, Oesterlen, V. v. Bruns, Taylor,[48]—we will only represent Rizzoli's (Fig. 34), which has been especially used for the fracture of rachitic curvatures, and which consists of two iron rings, the one applied above and the other below the site of greatest curvature; these rings hold the bone and are

connected by a bar through the middle of which works a screw. To the end of this screw is attached a plate, through which pressure is conducted at the eminence of the curvature which is covered by a pad. This pressure is increased till the bone is fractured. In order to measure the applied force a dynamometer may be attached to Rizzoli's osteoclast. The apparatus is a very simple one. The padded rings surround the bone; they are connected by the iron bar and fixed by screws; the large screw is worked down until the pad over the eminence of the curvature is thoroughly adapted, and then a

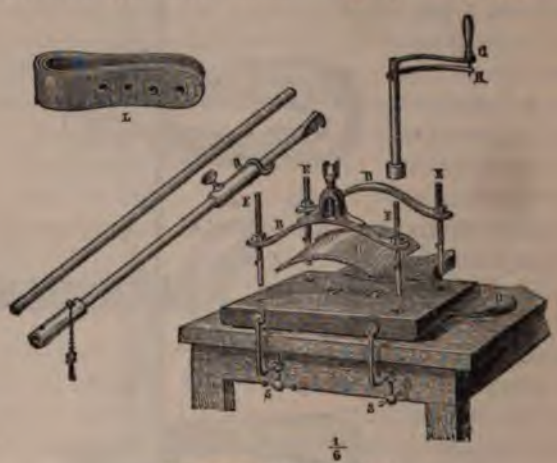


Fig. 35.—Robin's Osteoclast.

few quick turns of the screw will break the bone, often audibly. A fixation bandage or extension is applied.

The new apparatus of Robin and Collin has the advantage of breaking the bone at the exact spot desired; the fracture is usually transverse, and this apparatus is also suitable for breaking the bone quite near joints. These inventions have greatly stimulated resort to the osteoclast, especially in France.[49]

The Robin osteoclast consists of a strong wooden base which is screwed at *S* to a firm table. The wooden base is perforated for the insertion of iron bars *EE*, and these are fixed by the lever *D*. The arcs *BB* are movable on the bars *EE*, and these compress the plate *G*, by means of the screw-key *C*. The lever force is regulated by the spring *R*. The

force is applied to the periphery of the bone through the three-fold leather girdle *L*.

The new Collin osteoclast, which was devised for the correction of genu valgum, consists of a firm base, to the centre of which is attached a strong quadrilateral iron plate which may oscillate forward and backward; through this plate works a compression screw, which is movable so as to be applied, where desired, on the bone. Of the two lever arms only one is movable, and when it is approximated to the other, the requisite force for fracture is exerted. (See Fig. 36.)

In many cases the very simple Volkmann apparatus, which consists of a ring and a long lever arm, may be used. The

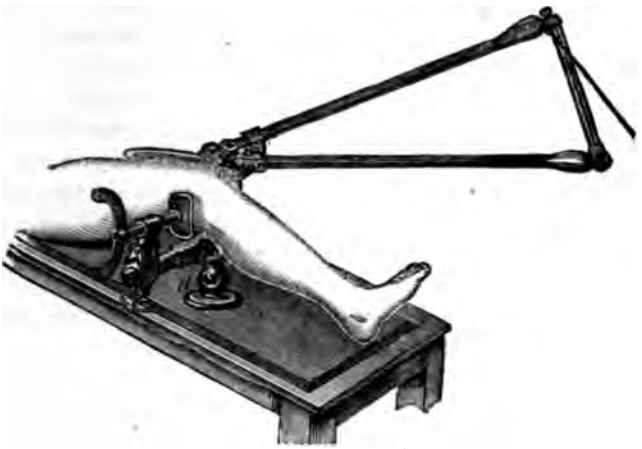


Fig. 36.—Collin's Osteoclast.

ring is pushed over the site where it is desired to cause fracture, and the requisite force is quickly applied through the lever.

According to Böckel,[50] of 120 patients with contracture of the extremities the above method succeeded in three-fourths of the cases, and for more than half the use of a simple apparatus sufficed. Thirty times osteoclasis was requisite, and with the exception of one case, it succeeded twenty-seven times in children ranging from eighteen months to eight years, and only failed three times.

Recent reports have strengthened the position acquired by osteoclasis and it is not surprising that statistical data should speak in favor of it over osteotomy. Pousson,[51] in ninety-eight

cases, has never seen much after-disturbances except in one case where there was a slight bruise.

In regard to the cutting methods, we must consider those involving the soft parts (skin, fascia, muscles, tendons), and those involving the bones (section of bones, removal of a portion).

The further subdivision is made into the so-called subcutaneous operations, which are performed through a small incised wound in the skin, and into the percutaneous operations, where the skin is severed in order to expose the part to be operated upon. While, in the days when man was powerless against wound complications the subcutaneous operations were naturally resorted to, since thus certain of the risks were avoided, in these days of antisepsis the percutaneous operations have had a wide prospect opened before them, since, by the free exposure of the parts, we may better recognize shortened tissue or the bands which prevent reduction of a deformity, and we may further the better separate them, and since we may, by Esmarch's bandage, avoid the hæmorrhage which would otherwise obscure the field of vision.

Of the operations on the soft parts, we must first consider those which consist in cutting the cicatrices which cause deformity. Where such cicatricial contraction exists we may reach our aim by simple incision of the bands, by transverse incision followed by vertical union, by flap operations, especially the Λ—, V—, and |—|-shaped incisions (Busch, Burns, etc.), by extirpation of the cicatricial tissue, and by transplantation of large flaps from the neighborhood.

The cutting of fascia and of aponeuroses is not frequently resorted to in orthopedics; usually this involves the palmar and plantar fascia, and the fascia lata in case of contractures, etc.

These operations may be also performed subcutaneously and percutaneously, and in regard to the palmar fascia we will speak later in connection with Dupuytren's palmar fascia contracture.

The cutting of single ligaments is also, in general, not often resorted to in orthopedics, although formerly the section of the external lateral ligament of the knee played a rôle in the treatment of genu valgum.

More frequently, it is a question of cutting different tissues,

as in Phelps' method of treating club-foot, where all the tissues which hinder redressement,—the skin, fascia, tendons, ligaments,—are cut, and the wound is then allowed to heal antiseptically.

In the orthopedic practice of earlier times, in particular, the cutting of muscles and of tendons for the correction of deformities played a very important rôle, and tenotomy is of far greater value than myotomy, and should be selected instead, seeing that the necessary wound is a slighter one, its cross-section a smaller one, and, owing to the speedier union, the subcutaneous operation will to-day, in the majority of cases, be given the preference. Especially is this the case for those tendons, such as the tendo Achillis and the tendon of the sterno-cleido-mastoid, which are not surrounded by any special sheath and therefore where the risk of permanent non-union need scarcely be taken into account.

The section of muscles and of tendons was even resorted to in the middle ages for the correction of deformities, but suppuration, etc., frequently resulted and this nullified the result. Tulpius, Solingen, Roonhuysen performed tenotomy; Lorenz, on the advice of Thilenius, in 1782, for the first time cut the tendo Achillis for the relief of club-foot, and Sartorius and others imitated him. In 1822, Dupuytren and others tenotomized for caput obstipum. Tenotomy, however, first gained acceptance as a valuable operation after L. Stromeyer (1831 to 1833) had learned how to avoid its risks, and we may, with justice, say that orthopedic practice was thus revolutionized as much as was ophthalmology by the discovery of the ophthalmoscope (Bauer). The enthusiasm which this operation evoked was all the greater, seeing that, in comparison with the great results it yielded, it could be termed a minor operation. Dieffenbach, especially, cultivated the method in his large practice, so that in his work on the section of tendons and of muscles, which appeared in 1841, he could report 120 cases of torticollis and 350 of club-foot where he had tenotomized, and in one year he performed no less than 250 operations of this nature.

As in the case of many new methods, tenotomy was resorted to far too frequently, and we may rightly speak of "excess in tenotomy" when we read of cases where twenty and more tendons were divided in a single individual. In a

large proportion of instances which were formerly tenotomized, we may to-day attain our aim through the use of orthopedic contrivances (elastic traction, etc.); there still, however, remain a large percentage of orthopedic affections (especially contractures of the foot, torticollis, etc.) where a tenotomy will considerably shorten the time requisite for treatment, and for this reason it should be resorted to. In any event section of a tendon will only be of utility when the necessary after-treatment is instituted, and herein there was formerly, and there is to-day, much still to be desired.

Union after tenotomy consists in the following steps: The small space between the severed tendon generally fills up with a little blood, the coagulum becomes organized; the paratendinous tissue is involved in the plastic infiltration, and since the original plastic material spreads into the connective tissue, the ends of the tendon become united by connective tissue fibres which possess all the characteristics of tense connective tissue. Paget,[52] Lebert, Ammon, Brodhurst, have carefully studied the steps of this process.

In regard to the technique of subcutaneous tenotomy, we need small, curved or straight, pointed or rounded, convex or concave knives, the so-called tenotomes, which should only make a short cut in the transverse diameter of the tendon. The pointed tenotomes, of which the slightly sickle-shaped tenotome of Dieffenbach may be taken as the type, have the advantage that no other instrument is required for the operation, and further, in that careful use does not carry with it the risk of unnecessary wounding of the tissues.

The blunt, rounded tenotomes possess various shapes. In their use the tissues are incised at the desired spot by a small bistouri; the tenotome is inserted into this incision and the tendon is cut. Two instruments, therefore, are requisite for this small operation, and this is always a disadvantage.

The little instrument of V. v. Bruns combines the advantage of both, in that the point is cutting and is curved forward to such a degree that, after, by a quick stroke, the tissues have been cut, the tenotome may readily be pushed down to the tendon and then the tenotomy may be performed without risk of injuring the neighboring parts.

Owing to the short time requisite for the performance of this operation anesthesia is not absolutely essential; still, many

authorities recommend it, seeing that the movements of the patient may interfere with the operation. With good assistants, however, especially in children, the limb may usually be held so that there is no indication for anesthesia on this score.

It is always essential that the patient should occupy a position in which the part to be operated upon may be steadied to the best advantage, and that the limb be so held that the shortened tendon may spring well forward. Tenotomy is then performed, as a rule, at the spot where there is least danger of injury to the neighboring parts and where the tendon has the least transverse diameter.

The incision on the border of the affected tendon should, as far as possible, be made in the direction of the fibres of the tendon; it should be small (to avoid entrance of air), and should

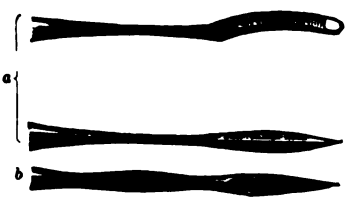


FIG. 37.—Tenotomes. *a*, Guérin's Lancet-shaped Knife and Blunt-pointed Tenotome; *b*, Stromeyer's Tenotome.

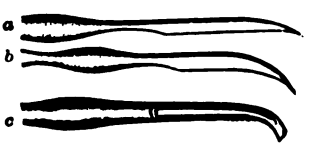


FIG. 38.—Tenotomes. *a*, Straight-cutting Tenotome; *b*, Dieffenbach's Tenotome; *c*, v. Bruns' Tenotome.

further be made on that side which is the most convenient for the operator in the use of his instruments.

The position of the tenotome during tenotomy is somewhat like that of a knife while peeling fruit; the tendon is rather held against the tenotome; the motion of the instrument should be rocking not sawing. The tenotomy may be performed either from within outward or from without inward.

In case of tenotomy from within outward the left hand of the operator, or of an assistant, holds the affected limb so that the tendon which is to be cut springs sharply forward; the operator, holding the tenotome in his right hand, inserts it into the small incision near the border of the tendon, carries the instrument flat under the tendon nearly to the skin on the opposite side, turns the instrument to an angle of 90°, so that the cutting surface lies against the tendon and this is severed by a number of slight tractions, while the thumb of the operating hand controls the action of the instrument.

When the tendon has been severed, and this is generally evidenced by an audible crackling, the tenotome is again turned on the flat and pulled out through the same incision, the wound being at once compressed by the finger and then dressed antiseptically.

In case of tenotomy from without inward, the limb is held so that the tendon is not put on the stretch, and the tenotome (blunt like Guérin's or Bruns') is inserted flat through the wound above the tendon, between it and the skin, until it has passed the tendon; the tendon is then made tense, the operator then presses the back of the knife outward, the tendon is cut through in part by the tension, and an audible crackling, with an immediate yielding, tells us that this has happened; the extension is relaxed, the little knife is turned and slowly drawn out of the wound horizontally; a compressive antiseptic bandage is at once applied.

It is important that the operator, or his assistant, should at once relax the tension of the tendon as soon as it has been cut, and that immediately on the withdrawal of the tenotome from the wound, the blood should be pressed out of it and an antiseptic dressing applied.

The correction of position should, as a rule, not be resorted to immediately after the tenotomy; it is preferable to wait until the trifling wound has healed, usually about three days at the earliest; the correction, further, should not be sudden but gradual.

The complications following tenotomy may be stated as the following:

1. Profuse hæmorrhage from wounding of a large vessel, which calls for a compressing bandage, rarely for the ligature.

2. More frequently it happens that, owing to movement on the part of the patient, the wound in the tissues is greater than is essential, or that the tissues on the opposite side are pierced. Such occurrences are of no importance if the after-treatment be in accordance with antiseptic principles.

3. Incomplete section of the tendon may lead to difficulties, seeing that the operator must forcibly rupture the remaining fibres, or else insert the tenotome again in order to completely sever the tendon.

Suppuration after tenotomy is to-day a rare occurrence; it may happen, however, in uncleanly children, and then care

must be taken to secure free drainage, lest gangrene, etc., of the tendon ensue.

Myotomy is less frequently indicated than tenotomy. At times free section through a large wound may be advisable, since we can thus better loosen cicatricial bands, etc. A large incision is especially indicated in Phelp's operation, or in the percutaneous section of the sterno-cleido-mastoid, in order to avoid, with greater certainty, injury to vessels and the resulting sequelæ. The modern operations on the osseous system mark still greater progress in orthopedics than the introduction of tenotomy. Such are the operations of osteotomy, osteoectomy, resection, arthrodesis, etc., and they have been made possible by the modern methods of treating wounds antiseptically. These operations constitute a most valuable advance in surgery and are applicable generally whenever osteoklasis and other mild procedures cannot promise sufficient result or are out of the question, or where treatment by apparatus, owing to cost and length of requisite time, cannot from the circumstances of the patient be instituted.

Although section of bone was performed in remote times (Avicenna) and lapsed into forgetfulness, and although in the pre-antiseptic era it was again practiced as subcutaneous osteotomy by A. Mayer and Langenbeck, yet severe after-disturbances, death from pyemia, etc., not infrequently occurred, and only on the advent of the antiseptic era did these operations on the bones become established, and they are, to-day, frequently practiced to circumvent deformity, to overcome anchylosis, old dislocations, and badly united fractures.

In regard to the instruments which are requisite for these operations, in addition to the ordinary scalpels, etc., bone knives or resection knives (Langenbeck, Billroth, Nélaton, Bruns, etc.), and rasps must be mentioned. To-day the chisel plays a great rôle in these operations (Billroth, Volkmann). The carpenter's chisel, which is sharpened on one side (Fig. 39, *b*) and answers for the removal of pieces of bone, is not only used but also the sculptor's chisel (sharpened on both sides, Fig. 39, *a*), which has the form of a slender wedge. The latter is resorted to for simple perforation of bone. The chisel must be constructed of well-tempered steel; it must be sharp and in various sizes. The handle should end in a metal knob or else be of hard wood so that it will present a broad, firm surface

for the hammer to act upon. The hammer may be constructed either of lead or else of hard wood (*lignum sanctum*, etc.).

Before the general introduction of the chisel operations, the saw, in particular the panel saw (Langenbeck, Adams), was widely used, and the latter, in particular, is for many instances a very useful instrument, since it is only dented at the upper end, and the soft parts, hence, may be the better protected. This form of saw is especially useful when it is a question of cutting through a superficial, readily accessible bone, or when the bone is sclerotic, or when only the cortex of the bone is firm. In the cutting of large bone surfaces, as in the

FIG. 39.—Chisels.

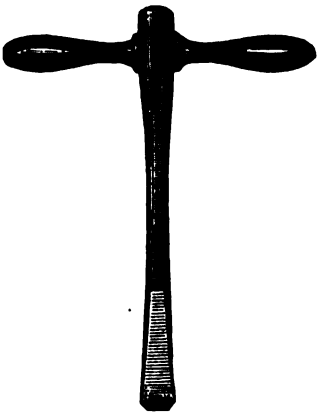


FIG. 40.—Billroth's Osteotome.

ordinary orthopedic resection, the saw is preferable, since it yields smoother sections, and then the resection saws of Szymanowski, Bruns, Farabœuf, Mathieu, and others, are valuable, especially those with large arcs; for many purposes the rotatory saws (Charrière's) and Ollier's "scie à volant" with elastic transmission are valuable.

The use of the chain saw is generally to be discountenanced, owing to the difficulty of obtaining proper antisepsis.

The bone perforator is used less for the purpose which its name implies than for the introduction of a ligature, and the instruments of Collin, Langenbeck, and others may be resorted to; the ordinary gimlet will usually answer. The bone scissors are rarely called for in orthopedics, and are only useful for the severing of thin bones with small narrow canals, or flat

bones, or fragile readily depressed bones (as in the tubular bones of children with thin cortical layer); the bone forceps, on the other hand, is frequently required for the purpose of leveling a surface, or, of removing sharp projecting portions of bone. Liston, Luer, and others have devised bone forceps.

Osteotomy, that is to say, the section of a bone without the removal of bone substance, may be performed in a variety of ways: as a simple linear osteotomy (generally transverse section), as more or less oblique or as bow-like osteotomy.

While formerly osteotomy was performed through as small a wound in the tissues as possible—the so-called subcutaneous linear osteotomy—in order to avoid the danger from entrance of air, since the introduction of antiseptics less weight is laid on the wound in the tissues, and under these circumstances the bone is freely exposed. Under careful antisepsis osteotomy is a safe and certain operation.

To cite a few examples: R. Volkmann,[53] in fifty-seven osteotomies, observed neither suppuration nor fever; in only one case was subsequent amputation called for, all the others yielding good results; in forty-two osteotomies Hofmokl reports thirty-one instances of healing *per primam*, suppuration in ten cases, one death; in 361 osteotomies Margary had three deaths (only one of which could be laid to the operation), and MacEwen,[54] in 835 osteotomies (557 of which number were performed on the legs) had no death. These good results, however, should not lead to excessive performance of the operation, for Owen says, "I have seen pyemia and death follow the operation when performed by a careful surgeon with all Listerian precautions, etc.;" where osteoklasis will lead to the same result it is to be preferred, since Pousson, for example, in 276 osteotomies noted severe disturbances ninety-five times (four times hæmorrhage, fifty-four times suppuration, etc.), and in only fifty-eight did union by first intention occur.

In the performance of osteotomy, formerly, the bone was bored through with the perforator a number of times, or after a single perforation the bone was sawed until it was possible to break it; to-day the chisel is the chief instrument used in the majority of cases (MacEwen's osteotome) and in order to note its progress in the depths of the wound the instrument is graduated (Reeves).

In the choice of site for the performance of osteotomy we

must take into consideration the necessity of not injuring the neighboring parts; as a rule, a vertical incision is made down to the bone; when necessary, muscles are cut through lengthwise, and tendons, etc., are pushed aside. After the chisel has been applied where desired it is driven by blows from the hammer, either the right hand of the operator holding the latter, or else, where great care is requisite, an assistant using the hammer and the operator guiding the chisel with both hands.

A simple "linear osteotomy" is performed as follows:

The patient is deeply anesthetised; as a rule Esmarch's bandage is applied;[55] the limb is shaved, washed with soap and disinfected according to antiseptic requirements, and is laid on a sand-bag or cushion covered with rubber-sheeting. A short vertical incision down to the bone is made at a point where the bone is as superficial as possible and where the vessels and nerves will be injured the least. A chisel of the breadth of the wound is inserted along the knife, so that when the latter is removed the former will rest transversely on the bone. By a number of sharp blows with the hammer the chisel is driven in until the bone has been nearly severed and the remaining cortical layer can be readily broken. The wound is again washed out antiseptically, is brought together by sutures and bandaged, and the limb is then placed in a retention bandage or splint, and slung up for awhile, a procedure which is of special utility in children, since the dressing is thus less likely to be soiled. If fever or other disturbance do not call for a change of dressing, it may remain in place for one to two weeks, and the retention bandage is to be worn until thorough consolidation has taken place. Ordinarily an apparatus must be worn for a number of months or even for a year.

A special variety of osteotomy is the semicircular (Meyer, Rosmanit, and others), where the bone is cut through in a semicircular line, eversion of the edges being thus prevented. Greater contact of the surfaces and better adaptability are obtained by this method. Under this heading belongs the trochlea-shaped osteotomy which Defontaine[56] has recently performed in case of anchylosis of the elbow.

We must further mention vertical osteotomy. This procedure was devised by Ollier[57] for the correction of rachitic curvatures and at the same time to lengthen the shortened

bones through longitudinal extension applied to the cut surfaces. This procedure calls for great permanent extension in order to overcome the resistance of the muscles, and it may also require tenotomy. Ollier has thus secured an increase in length of from .7 of an inch to 1 inch and a fraction.

In case of very considerable, and in particular right-angled curvatures, where shortening is lacking or even increase in length is present, the wedge-shaped osteotomy (*osteotomia cuneiformis*) is to be preferred. A wedge of bone is removed from the convexity of the curvature and the cortex of the bone is broken toward the concavity. In general, this wedge-shaped excision is performed in order to obtain good position in case of angular anchylosis. A wedge of bone is removed sufficient in size and in form to allow of restitution of the bone to a good position. The apex of the wedge lies in the bone, that is to say, the latter is not entirely cut through. The posterior wall is fractured with due regard to the safety of the neighboring parts.

The limb, rendered bloodless, is firmly held, and a sharp carpenter's chisel is placed obliquely on it. With a few blows of the hammer the chisel is driven in to the requisite distance, injury to the periosteum being avoided as much as possible; the opposite side of the wedge is similarly cut, and, after the remaining bridge of bone has been broken, the bone surfaces are adapted the one to the other, the wound is sutured, dressed antiseptically, and the bone is held in position by a suitable retention apparatus.

In certain instances, where, for instance, the bone is very compact, as in the knee, the saw may be substituted for the chisel, even though resort to it requires greater exposure of the bone; in this case the periosteum must first be loosened and pushed out of the way.

Rarely is it requisite after the wedge-shaped excision to bring the bone surfaces together by suture or by nails.

A number of new orthopedic operations, allied to osteotomy, have been devised, chiefly by Ollier,[58] with the aim, in the young, of checking or of entirely preventing local growth of a bone, and exceptionally of increasing this growth. These operations are, in particular, indicated where the growth of two connected bones is unequal, especially in a longitudinal direction, as, for example, in the bones of the fore-arm, thus

leading to deformity. Where the object is purely to check growth, simple chondrectomy may be resorted to. In case of beginning deformity (as in genu valgum, etc.) a simple incision may be made into the epiphysis; often, however, this will not suffice, although the attempt risks nothing (Ollier.)

Where the aim is to stop growth, particularly in older children, chondrectomy is indicated. This operation consists in removing a portion of the epiphysis, occasionally its entire thickness. For example, where the radius from one or another cause is shortened and where the growth of the ulna may lead to hideous deformity (subluxation of the hand), here only resection of the epiphysis can permanently check the deformity.

As yet we have had too little experience with these operations, which are based on theoretical views in regard to the growth and the regeneration of bone; the same remark holds true of the proposals to artificially cause increase in the growth of bone by scarification of the periosteum, by the insertion of irritants (such as the driving of a nail) in the neighborhood of the epiphysis. Ollier, for example, was able to increases the length of the tibia by about half an inch through repeated cauterization of the diaphysis, or through subperiosteal laceration.

The resection of a portion of bone, or of a portion from two bones in contact, is often resorted to since the advent of the antiseptic method of wound treatment. The so-called resection *en bloc* (Gurdon Buck) is utilized in case of bony anchylosis of joints (anchylosis of the knee at a sharp angle), either for the purpose of obtaining a movable joint (as at the elbow, the shoulder, the jaw) or else only in order to obtain better position from the stand-point of function.

Further still, resection of a joint is undertaken in order to obtain better function in irreducible or in old dislocations, and also in instances of congenital joint deformity.

In case of curvatures, resection of the joint is also resorted to, as for example, in case of aggravated pes equinus, and we must also refer here to the procedure, frequently performed to-day, of removal of wedges of bone from the foot in instances of club-foot.

Less frequently is resection from the diaphysis indicated, as, for example, in badly united fractures where union has occurred at an angle, in pseudarthrosis, etc. Güterbock[59] has

excised a piece from a large radius, in order to correct angular ulnar-ward bending of the fore-arm.

Resection, performed for orthopedic purposes, often differs somewhat from the ordinary operation. Instead of the usual longitudinal incision, flaps are often raised in order to secure good exposure of the bone. Only sufficient bone is in general removed as will suffice to obtain correct position, etc.

In case of resection *en bloc* we must carefully estimate the size of the wedge which it is necessary to remove, and, where, in addition to flexion, there exists a lateral deviation of the bone, the section, if removed, must be higher on the one side than on the other.

Usually, the requisite size of the wedge may be estimated by the eye; sometimes it is necessary to make a plaster model of the limb, and with this to experimentally secure a wedge of the necessary size.

We must refer, under this heading, to the many methods, recommended in particular by Albert, of operating on the joints, such as removal of the excess of bone from some part of the joint surface, whereby an entirely useless limb has its function restored, partially at least, or whereby firm supports may be attached to such a limb. (See, in this connection, the subject of paralytic deformities.)

Plastic operations may also be resorted to for orthopedic purposes. Nussbaum, Ollier, and others, have been successful with bone transplantation in case of pseudarthroses, etc.; and Albert has undertaken a plastic method in case of a congenital defect in order to afford good support to the affected limb. In a female child, nine months old, with congenital defect of the tibia, he opened the knee-joint and implanted the fibula between the two condyles. The child convalesced without fever, and bony union was obtained with the limb at but a slight angle.

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CHAPTER II.

RACHITIS.

THE most frequent cause of deformity, in particular of the lower extremities, is rachitis. Under this term we understand a constitutional disease, a special anomaly in nutrition, which is due to an excessive increase in, together with a deficient calcification of the elements from which bone is formed. This disease is most prone to occur in childhood. The synonyms for rachitis are: German: Englische Krankheit, Zwiewuchs; French: rachitisme; Italian: rachitismo.

This disease is found the world over,[1] especially in cold and moist climates (Holland, England), and it affects, in particular, the poorer classes who live amid bad hygienic surroundings, their houses being dark and ill-ventilated, their nourishment insufficient and of poor quality. Rachitis, indeed, constitutes a very high percentage of the diseases which affect dispensary patients. Owen places this percentage as high as 30 per cent.

It is questionable if heredity plays a rôle in the establishment of rachitis. Many authorities claim that it is an hereditary form of syphilis,[2] but this view is not tenable for the majority of cases.

In general, bad hygienic surroundings, exclusive nourishment on bread, pap, and poor milk, insufficiency of light and of air, these factors are very influential in the etiology of rachitis. The disease is only exceptionally met with in infants reared at the breast, and more frequently in those which are bottle fed.

Baginsky and Roliff have been able to produce rachitis, experimentally, by removing the lime salts from the nourishment; others by the administration of lactic acid. Heiss, however, has not been able to confirm the latter statement.

Rachitis may begin even in intra-uterine life; Chance, in-

deed, claims that in all cases such is the origin. The most frequent form of the disease is infantile rachitis, which appears during the first two years of infancy, that is to say, during the period of dentition (from the fourth to the thirtieth month). While, further, rachitis often enough develops in childhood, it is an infrequent affection in adults and in old age. The disease generally appears extensively throughout the body, rarely being purely localized.

After vague general symptoms, such as fever, diarrhœa, disturbances of digestion, tendency to catarrhal affections, profuse perspirations, the nutrition of the body diminishes and the alterations in the bones appear. These alterations affect very differently the various bones, and they are the chief cause of curvatures, the abnormlly softened bones yielding to the traction of the muscles.

In nearly 1,000 cases Treeves found almost constantly swelling of the lower end of the radius and of the ulna; in 250 cases the clavicle was bent, in 115 the humerus, in 210 the spinal column was affected, usually in the form of skoliosis. Most frequently the changes were noticed in the lower extremities; in 300 cases the femur was bent to a greater or less degree; in 415 genu valgum, or bow-legs, were present; in 394 the joints were enlarged; in 294 genu valgum predominated. Chance, also, found that thickening of the lower end of the radius was a constant phenomenon. In 600 cases he determined thickening of the malleoli 300 times, bow-legs 368 times, genu valgum 396 times, curvature of the femur 142 times.

The changes in the skull are of general interest. The most essential consist in an enlargement of the occiput out of proportion to the face. Shaw states this relation to be 7:1 instead of 6:1. The parietal protuberances project markedly, the fontanelles remain open. Elsässer first called attention to the craniotabes (the thinning out of the bones of the posterior portion of the skull). This thinning results from pressure on the bones when the child is recumbent, and it may lead to severe disturbances, such as spasm of the glottis.

In the thorax the changes first appear as a swelling at the point of junction of the ribs and the cartilages, forming the so-called rachitic rosary. Gradually the ribs yield to the inspiratory traction, and the lateral walls of the thorax, where the ribs have the least resisting power, sink in, the sternum

projects like the prow of a vessel and presents the appearance of a hen's breast (*pectus carinatus*). This is a frequent rachitic deformity, and a further etiological cause is the pressure of the arms against the sides.

In the spinal column, in addition to the softening of the bones and the swelling of the cartilages, the weakening of the muscles is effective in leading to deformity. Owing to the lack of power in the muscles the spinal column bends and, in course of time, permanent deformity ensues, usually a skoliosis or lateral curvature.

Under the influence of the rachitic softening of the bones the pelvis undergoes the characteristic changes leading to the flat, the elliptical, the kidney-shaped, etc., pelvis. The changes here are met with in varying degree and extent.

The changes in the extremities are of chief interest to us. At the outset, the thickening and broadening of the epiphyses are characteristic. These alterations lead to the joints appearing as if double, whence the expressions double-jointed, *Zwiewuchs*, etc.

In addition to the deformity resulting from enlargement of the epiphyseal cartilages, a similar effect may follow on unequal extension of this process, and when we add to this unequal traction of the muscles the highest grade of deformity may ensue. According as to whether the child walks or not, the deformity varies in characteristics. Usually, we find an increase in the normal curvature of the limbs, that is to say, in curvature outward. In aggravated instances an angle is formed, especially in the lower third of the lower extremities, and the deformity may extend to such a degree that the feet are crossed.

Curvatures with the convexity inward (Figs. 41 and 42) are less frequently met with, and in these instances, unequal pressure on the knees in creeping probably plays a rôle. The most complicated curvatures may result from repeated partial, or total fractures, and these are indeed frequently symptomatic of rachitis.

The rachitic changes of the upper extremities are of less importance. The most characteristic is the projection of the lower epiphysis of the radius (Fig. 42). The curvatures of the humerus, usually with the convexity inward, form a zigzag line with the fore-arm, where the convexity is outward. Ra-

chitic changes in the clavicle are often found. The rachitic flat foot is a characteristic affection.

The pathological findings consist in an increase of osteoid matter, with diminished and unequal calcification. The epiphyses of the hollow bones are thickened, the periosteum and medullary substance are hyperæmic; on section the epiphyseal line is irregular; here and there in the bones are zones of thickening; the medullary spaces spread irregularly into the thickened sections; the periosteum may be readily detached and is very succulent.

These stages of rarefication and of effusion may be differ-

FIG. 41.—Rachitic Curvature of the Lower Limbs.

FIG. 42.—Rachitic Genu Valgum in a Four-year-old Child

entiated from the stages of beginning deformity, of consolidation and of eburnation.

The epi- and diaphyseal thickenings disappear only slowly, and not infrequently they are permanent. In case the rachitis is cured there results a rachitic sclerosis, that is to say, an increase of the bone, as calcification and ossification of the osteoid layers, whereby the bones increase greatly in weight, and they become so hard and so compact that it is often very difficult to crush them.

Usually a greater or less disturbance in the growth of the body follows on rachitis. According to v. Rittershain, for

example, the mean height of the body, at a given age, is never attained. Not uncommonly rachitis results in the individual being dwarfed.

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CHAPTER III.

TORTICOLLIS.

UNDER the term torticollis or wry-neck is understood that pathological position of the head when it is bent toward the shoulder, and the chin is directed toward the opposite side. The condition may occur before birth, during delivery, or it may be acquired later in life. The acquired form is divided into the myogenous, the arthrogenous and the cicatricial, and in addition there is a variety called the compensatory which is seen as an accompaniment of aggravated skoliosis.

In regard to congenital wry-neck heredity possibly plays a rôle; at least Petersen reports an instance where a number of children in the same family were thus affected. In the majority of congenital instances, however, the wry-neck depends on a congenital deformity of the vertebræ of the neck, or else on lack of space for the fœtus during intra-uterine life (the result, for instance, of deficiency in the amount of liquor amnii). That contracted space or abnormal position in the uterus is a factor is rendered probable by the frequency of other deformities as accompaniments of wry-neck.

According to Stromeyer, in a large proportion of cases torticollis is due to rupture of muscular fibres intra-partum, and the subsequent cicatricial contraction. This view is shared by Fischer, Busch and others. Volkmann does not entirely reject it. Petersen,[1] however, was not able to determine a direct connection between the subcutaneous ruptures, the hematomata of the muscles, and wry-neck; neither did the experiments of Fabry and Witzel prove such a relation. According to Petersen hematoma is rather found in an already existing torticollis, and Fasbender has seen the hematoma on the side opposed to the wry-neck.

A variety of etiological factors must be taken into account. We must grant that in certain of the cases traumatism during

delivery[2] (breech presentations, the application of forceps) was the causal factor. For instance, Fabry,[3] in fourteen cases, found that in eight the presentation was of the breech and in four that the forceps was applied. A larger proportion of cases are myogenous in nature, being dependent on rheumatic and other influences which lead to a shortening of the sterno-cleido-mastoid. The posterior muscles of the neck may likewise become shortened on one side, and Délore calls this condition torticollis posterior. In rarer instances shortening of the platysma myoides may result in wry-neck.

Paralytic torticollis may be met with, seeing that paralysis of one sterno-cleido-mastoid may be accompanied by shortening of the other. Disturbances of the nerves, such as paralysis of an accessory nerve, may lead to torticollis. We are particularly likely to meet with torticollis as an accompaniment of hysteria, and it has been observed in the course of this affection as a clonic spasm of the muscles of the neck.

Torticollis of an arthrogenous nature is dependent on diseases of the cervical vertebræ and of their ligaments. It usually follows on unilateral cicatricial contraction. The fungous and tubercular diseases in this locality may be cured with angular anchylosis, and we will refer to this under the subject of kyphosis.

Cicatricial torticollis results from burns, abscesses, lupus of the soft parts of the neck. The cicatrices following on degeneration of the glands of the neck are also causal factors. Torticollis has also been noted as an accompaniment of tumors of the sterno-cleido-mastoid. Graser has lately reported a striking example.

Since the time of Tulpius, Robert, Bouvier, and others, anatomical descriptions of torticollis have been rare. The conditions observed on operative interference have been, on the other hand, frequently described and are important. In certain severe cases nothing abnormal has been found either in the muscle or its surroundings which would point to an antecedent trauma. In many cases, however, there have existed cicatrices in the muscle, and occasionally very marked changes which could only be due to a severe and extensive inflammatory process (Volkmann).

Hensinger,[4] for example, found the sterno-cleido-mastoid of one side one-half an inch shorter than that of the other. The

shortened muscle, however, was increased in breadth, and at the broadened and thickened portion there remained no muscular substance but there existed a soft, sinewy cicatrix.

Witzel,[5] at the autopsy on a woman of forty-four, affected with wry-neck of the myogenous variety, found the cervical vertebræ curved with convexity forward; the left sterno-cleido-mastoid was altered into a round, sinewy band, its border being only four inches long and .39 of an inch wide, while the right sterno-cleido-mastoid was seven inches long, and .56 of an inch wide. There existed asymmetry of the face and head

FIG. 43.—Congenital Torticollis. (Asymmetry of the Face.)

and a compensatory curvature of the lower spinal column (convex to the left).

Whether the cause of the wry-neck be congenital or not, there is rarely lacking a certain asymmetry of the face.

Nélaton, Eulenberg, and others, claim that this asymmetry is dependent on a lesser development of the vessels and the nerves on the side of the concavity; Dieffenbach considers it due to traction of the shortened muscles; Witzel believes that it results from stretching of the soft parts, in particular of the muscles of the healthy side of the face, whence the shape is imparted to the growing skull.

In Fig. 43, a man of twenty-four is represented with congenital right-sided torticollis and quite marked asymmetry of the face.

The symptoms of torticollis consist in the abduction of the head toward the affected side, associated with a traction (rotation) toward the healthy side. There exists an abnormal

position of the head and neck which results from the approximation of the insertion points of the affected sterno-cleido-mastoid. The chin is drawn upward, the head pulled somewhat backward. The ear is nearer the shoulder of the affected side; the projection of the muscle is very striking, and the insertion points of the sterno-cleido-mastoid are usually very well marked (Fig. 41). The neck appears not to exist on the affected side; the entire half of the face on the same side is shorter and thence the appearance of asymmetry.

We may readily detect limitation of the active and passive movements.

It is not sufficient for diagnostic purposes to establish the

FIG. 44.—Torticollis, Lat. Sin.

FIG. 45.—The Same, after Tenotomy.

mere fact of the existence of wry-neck. The cause of the deformity must be sought for. The rational history must be carefully weighed; the cervical vertebræ must be examined to see if pain can be evoked on pressure or if there exists any swelling. Diseases of the vertebræ (in which event pain, fever, etc., are present) and dislocation of a vertebra must be differentiated.

In case of myogenous wry-neck the contracted muscle may be felt on the side of the concavity, while in dislocation of a vertebra such is not the case.

Boyer's statement that in paralytic wry-neck the abnormal position may be readily overcome is not an absolute one.

The prognosis of wry-neck, particularly the common myo-

genous form, is in the large proportion of cases good. By means of suitable apparatus, and in aggravated cases by means of tenotomy and the proper after-treatment, the deformity may be overcome, and even the great asymmetry of the face will then disappear after a few months.

In congenital wry-neck, the result of muscular rupture, if it be seen before cicatricial contraction of the sterno-cleido-mastoid has become established, the wearing of a suitable neck-bandage for a few months will prevent permanent contracture. Usually, however, the affection in an early stage is

FIG. 46.—Sayre's Wry-neck Apparatus.

FIG. 47.—Bruns's Wry-neck Apparatus.

overlooked, and is only determined after it has reached a considerable grade.

While, then, in infants, daily repeated rotation, manipulation with subsequent fixation, and in older cases, daily extension by means of Glisson's swings (Berend, Petersen) will suffice to effect cure, in adults, as a rule, special apparatus or tenotomy is requisite.

The simplest apparatus consists in the use of elastic traction. Sayre, for example, draws the head to the side opposed to the deformity by means of a rubber band which is attached to a strip of plaster around the forehead and to an axilla strap around the shoulder opposed to the deformed side. By varying the tension of the rubber band the head may be maintained in good position (Fig. 46).

For the rectification of wry-neck a number of appliances have been devised, such as those of Delacroix, Bonnet, Bouvier,[6] Mathieu, Collin, Bigg, and others. These take their point of resistance on the trunk and by means of screws and joints the faulty position is rectified. A number of these appliances are attached only to the upper part of the trunk; the majority, however, are provided with pelvic bands, dorsal splints, etc.

Bruns's apparatus consists of four padded sheet-iron splints, which may be curved to correspond to the shape of the parts to which they are to be adapted. These splints are united into a quadrilateral frame which may be slipped over the head. Union of the splints is effected so that the shoulder parts are movable. At the centre of the convexity of the shoulder and thoracic portion there is a screw-joint by which the component portions of each splint may be approximated, and into which the steel tubular rods, which are attached to the head, are inserted. These rods may be screwed up or down to suit the individual case, and their extremities are cushioned. The apparatus is attached to the body by straps which fit on to hooks in the splints. (See Fig. 47.)

Weinberg[7] has devised a combination of a chin-plate with shoulder straps, united together by springs and screws, the action of which is to approximate both portions of the apparatus. Lücke[8] has devised a similar apparatus for lifting the head in case of contraction of the sterno-cleido-mastoid as well as for use in case of caries of the cervical vertebræ.

Richard's apparatus (Mathieu) consists of a leather pelvic girdle, into the back of which is adapted an iron splint which extends vertically upward. At the upper third of this splint there is a longitudinal bar to which axilla straps are adapted. These straps pass under the axillæ, over the shoulders, and are attached posteriorly to the leather waist band. The upper extremity of the vertical bar is connected by means of a movable ball and socket-joint with a leather cap which fits the head. By means of this apparatus the head may be fixed in any desired position. (See Fig. 48.)

In Langgaard's[9] apparatus the head, which is drawn down toward the shoulder, may be lifted up and the pathological twisting may at the same time be rectified. Reynders's[10] apparatus (Fig. 49) consists of a pelvic band, *a*, steel dorsal splints, *b*, transverse bar, *c*, axilla-straps, *k*, and movable

lateral splints, *m*. A malleable iron head-piece is attached by straps, extending over the forehead and under the chin. This head-piece is provided with openings for the ears. It is connected with the spinal splint by an iron bar, *d*, which is divided into three joints, *efg*. These joints may be fixed at any desired angle. At *h* this iron bar fits into the spinal splint, and it may be held at the requisite height by the thumb-screw, *n*.

The Eulenburg-Langenbeck[11] apparatus (Fig. 50) may also

FIG. 48.—Mathieu's Torticollis Apparatus.

FIG. 49.—Reynders's Torticollis Apparatus.

be used after tenotomy, and by means of it the head may be maintained in any desired position. A large number of apparatuses aim at overcoming the contracture of the sterno-cleido-mastoid by means of extension of the head. An interesting apparatus on account of its marked simplicity is that of Petrali[12] (Fig. 51). It consists of three pieces of wood, one horizontal (*C*) and two vertical (*AB*). The vertical pieces are cut out to fit over the shoulders. This apparatus is attached to the body; two bands hold the chin upward; one band opposes rotation of the chin; a cravat-like band straightens the

curvature of the spine; another band pulls the head over to the side opposed to the contraction. Popoff's[13] extension apparatus is also useful in this connection, and it will be referred to under the subject of caries of the cervical vertebræ. Davis' apparatus consists of an arc-like frame fitting over the head and taking purchase on the shoulder toward which the head is bent.

Of non-ambulant apparatuses we would refer especially to the Esmarch extension bed. It is a slanting plane on which the patient is fastened by means of Glisson's slings. The

Fig. 50.—Eulenburg-Langenbeck's Apparatus.

Fig. 51.—Petrali's Apparatus.

patient may rest with relative comfort on this bed, being able to read, do hand-work, etc. He need not undress.

Délore and others recommend forcible reposition under anesthesia. The rotation of the head is accomplished by slowly increasing manipulations. When the aim has been secured the head is held in position by means of a silicate of soda bandage encircling the chest, neck and head. This bandage may be strengthened by the insertion of steel blades. In the majority of severe cases of myogenous wry-neck tenotomy or myotomy of the shortened muscle is the first step toward speedy cure.

In 1670 this operation was often resorted to by Roonhuysen. In 1822 it was first performed subcutaneously by Du-

puytren, and since his time it has been frequently done. In 1841 Dieffenbach recorded sixty-two cases.

By moving the head toward the sound side the operator determines which portions of the muscles are chiefly shortened. Occasionally, division of the sternal portion alone will suffice; again, both insertions or even other muscles must be cut in order to obtain correction of the deformity. The operation may be performed with the patient in the sitting posture, or lying down. Anesthesia is occasionally advisable. An assistant pulls the head over toward the opposite side until the insertion of the muscle becomes prominent. A second assistant may make downward traction by grasping the arm at the elbow. Usually both insertions of the muscle must be divided. The two incisions for this purpose are made about .7 of an inch above the border of the clavicle. When the division is made from within outward (Dieffenbach, Hüter, Sayre) a sickle-shaped tenotome is inserted on the flat under the tendon of the muscle until its point lies under the skin of the opposite side. In drawing the knife out the tendon or the muscle is divided by the point, the thumb of the operator making counter-pressure. The sudden yielding of the severed portion is evidenced by a snap.

When the section is resorted to from without inward a convex tenotome (Little's) is used. A fold of the skin is raised, the tenotome is thrust through this in front of the muscle, and the latter is divided by pressure on the back of the instrument. Many operators are opposed to this method on account of the risk of wounding a blood-vessel. Other operators recommend making a small incision by the bistouri, inserting a blunt-pointed knife through this incision, and dividing both the insertions of the muscle.

After the completion of the operation the wound is dressed antiseptically. For four to five days the patient must remain in bed, the head being maintained horizontally. Then the requisite orthopedic after-treatment must be resorted to. Klopsch, as early as the third day, applied permanent extension to the muscles of the neck by means of traction through an apparatus attached to the head. In this respect he imitated Stromeyer. Other operators deem it advisable to wait until the fifth day before resorting to orthopedic treatment. Fixation by means of cravat-like apparatus is, according to Klopsch,

Langgaard and others, insufficient. Such apparatus consists in a tight paste-board cravat which, being higher on the affected side, prevents the head from returning to the abnormal position. These retention cravats are more lasting if constructed of felt, metal (Mathieu), leather (Charrière[14]), or silicate of soda (Falkson[15]). Petersen begins treatment by accustoming the patient to the apparatus which he will be obliged to wear. When he can wear it for at least one hour three times daily, he performs myotenotomy. Two to three days afterward, the patient is subjected to treatment on the extension bed for two hours, thrice daily, and in the intervals he wears a Sayre cravat. In order to increase the traction force the ring of Glisson's sling may be attached more laterally over the iron brace, and thus the head is drawn over to a greater degree toward the healthy side. Port[16] resorts to elastic traction after tenotomy after the manner shown in Fig. 52. The thorax is encircled by a plaster jacket.

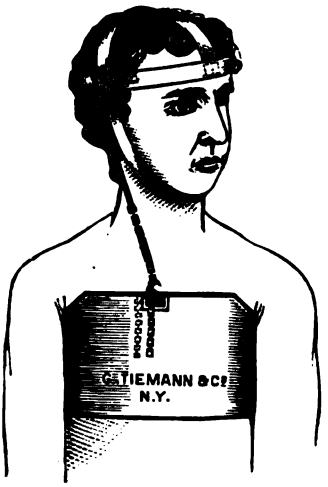

Fig. 52.

Special ambulant apparatuses are more frequently used. For instance those consisting of a jacket to which a jury mast and Glisson's slings are attached. H. Bigg, and others, have devised apparatus of this nature. The apparatuses which fix the head toward the healthy side, which over-correct the deformity, so to speak, are still more preferable: such as the apparatus devised by Richard, by Eulenburg, by Reynders, by König, etc. Occasionally, tenotomy of the sterno-cleido-mastoid does not suffice, and it becomes necessary to sever the anterior fibres of the cucullaris, or even of the levator scapulæ, when these fibres, after division of the sterno-cleido-mastoid, oppose reposition of the head. Dissatisfied with the result from subcutaneous myotomy in a number of aggravated instances, since new cicatricial bands formed in the deeper parts, which prevented reposition, Volkmann resorted to the following procedure: He laid the muscle bare by a large vertical

incision along its inner border, and severed it, as also the tense bands below it and in its neighborhood. In certain cases he even extirpated the fascia, etc.

The result in all the instances was good, union occurring by first intention. The after-treatment was relatively short and ended in permanent cure of the deformity. One of the most aggravated cases was an officer in active service. A number of surgeons, for instance Heinecke, resort to this method. It has the advantage of allowing the operator to control the steps of the operation, and the risk from hæmorrhage is far less.

Heinecke sutures the wound with catgut. He exaggerates the correct position of the head and maintains it by a pasteboard bandage covered with silicate of soda, extending up to the ears and down to and around the shoulders. After fourteen days union is usually obtained and further treatment is unnecessary.

In spastic contraction of the sterno-cleido-mastoid, particularly, certain operators—de Morgan,[17] Wood,[18] Annandale—have excised a portion of the accessory nerve with good result.

In paralytic wry-neck, on account of the liability of the occurrence of secondary contraction of the antagonistic muscles, energetic electrical treatment and massage are indicated.

In case of cicatricial wry-neck, subcutaneous section of the cicatrices, or excision followed by precautionary measures against shortening, are called for. In instances of osseous wry-neck special apparatus must be resorted to, and of this we will speak under the subject of kyphosis of the cervical vertebræ.

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CHAPTER IV.

DEFORMITIES OF THE SPINAL COLUMN.

DEFORMITIES of the spinal column are of the greatest possible interest, owing to the frequency with which they occur and their great influence on the health and capacity for work of those affected.

For anatomical and physiological details I must refer to our text-books on physiology, in particular to the works of the brothers Weber, of Henke and Meyer, etc. I only desire to note here that the so-called physiological antero-posterior curvature of the spine present in adults does not exist in the new born. In the infant the spinal column is straight, and only gradually, after the child has begun to sit up, does the column uniformly curve backward. Later, under the influence of walking and standing, the pelvis becomes inclined, the lumbar spine curves forward, and gradually the two compensatory curves are formed, that is to say, convex curvature backward in the thoracic region, and convex curvature forward in the cervical and dorsal regions. This physiological curvature is of great importance, since the body thus acquires elasticity.

According to the direction of the curvature the following subdivisions are made:

Forward curvature is called Lordosis,
Backward " " " Kyphosis,
Lateral " " " Skoliosis.

These varieties of curvature are not always regular in one plane but are often very complicated. It is useful, further, to differentiate the curvatures from the flexions of the spinal column. According to the causal factors the division is made into congenital curvatures, which are rare, and into acquired curvatures, which are ordinarily met with. The latter are designated as curvatures due to habit, as static, traumatic,

pathological, etc., curvatures. According to the behavior of the curvature on suspension we speak of mobile and fixed or stationary curvatures.

Lordosis.

Lordosis is the rarest variety of antero-posterior curvature of the spinal column. The column is curved with the convexity forward, and the deformity is almost exclusively limited to that portion of the spinal column which normally projects forward, that is the neck and the lumbar region, in particular the latter. Lordosis of the cervical region is rare; it is very exceptionally congenital, and is usually due to muscular action.

Lordosis is frequently the result of the occupation of the individual. It is met with in people who carry weights in front of them; also in tailors, who, from the constant posture on their benches, acquire contraction of the ileo-psoas muscles, and this results, when the individual is erect, in lordosis.

All processes which lead to great obliquity of the pelvis may result in lordosis. Among such causes may be mentioned contracture of the hip-joints, large abdominal tumors, muscular paralysis eventuating in pathological increase of the physiological curvature. Busch[1] gives a marked illustration.

In the large group of compensatory lordoses we must mention those which are associated with congenital luxation of the hip, with pathological luxation of the hip, with contractures, etc. Here, owing to the great pelvic obliquity in standing and in walking, the upper surface of the sacrum approaches the horizontal plane, and the patient is thence compelled to bend his lumbar region forward and at the same time to hold the upper portion of his body backward.

Lordosis rarely attains the degree of fixation, in the paralytic form certainly not. In case of lordosis following on coxitis, etc., however, as a result of permanent unequal pressure, the vertebræ may gradually attain unequal height in front and behind, and then from anatomical alterations the lordosis may become fixed. In lumbar lordosis of high degree, ordinarily the retraction of the loins, the projection of the abdomen and of the gluteal region, are at once apparent. Examination in the dorso-recumbent position with flexion of the limbs, etc., will enable us readily to determine as to whether the condition is movable or fixed.

The treatment must be mainly prophylactic. In the management of the coxitis care must be taken to prevent permanent pelvic obliquity and angular contracture of the hip-joint.

Among the special therapeutic points we may mention suitable gymnastic exercises, the lying on the abdomen for a considerable time daily, frequent climbing of a steep ascent, etc.

The apparatuses recommended for lordosis consist generally of an abdominal band, two lateral axilla bands, and an elastic band which prevents the projection of the abdomen and of the lower part of the thorax.

Heather Bigg, by the insertion of an endless screw in the

FIG. 53.

FIG. 54.—Nyrop's Lordosis Apparatus.

centre of the lateral splint, has enabled us to tighten at will the bandage which encircles the abdomen.

Nyrop's lordosis apparatus is readily understood by consulting Fig. 54. In Fig. 53 the purchase-point of the pelvic band is seen.

The apparatus consists of a steel spinal splint, *a*, with a cross-piece above to which the axilla straps are fastened. The pelvic band takes purchase through two pads, one of which is shown at *e*. To a cross-piece, *b*, is attached an elastic abdominal band, *d*, by means of which projection of the abdomen is prevented.

KYPHOSIS.

In the second variety of antero-posterior curvature, increased flexion in a segment of the spinal column leads to

backward curvature, to which, in general, the term kyphosis is applied.

It is useful to differentiate here the so-called round backs, from the pure kyphosis (flexion) which generally results from spondylitis.

The so-called round shoulders are met with in young people with relaxed ligaments and muscles, and the condition results from the habitual assumption of faulty position. Anxious mothers often deem this condition the first symptom of beginning deformity. In certain instances the entire spinal column above the sacrum presents a flattened arc with convexity backward. The scapulæ sink in forward and their apices stand out like wings from the thorax. In other instances the

FIG. 55.—Faulty and Correct Position in Reading. (Roth.)

position is not assumed by the individual but the vertebræ are abnormally movable and the normal curve of the spinal column thus readily becomes exaggerated. The lateral contour is not asymmetrical and the scapulæ do not alter their position to the one side or the other.

As a rule, the greatest degree of curvature exists in the median portion of the dorsal region, which is tense, owing to the stretching of the muscles. Round shoulders are also found among adults whose occupation requires constant bending forward, and also in those who carry weights on their backs. Lane[2] has lately recorded a marked instance in an individual who in his youth was obliged to split wood. Here the antero-posterior curvature was so excessive as to give the appearance of a wedge.

Certain of the kyphoses met with in old people may be traced to their occupation. As a rule, however, kyphosis here results from senile muscular weakness and tissue atrophy.

A further variety of round shoulders is found in children from two to three years old who present evidences of rachitis. This variety is, in general, rare. It is not fixed, but disappears on the assumption of the horizontal position. It is due to great relaxation of the muscles and ligaments and to the softness of the bones.

The habitual carrying of the shoulders forward is a predisposing cause of lateral curvature. We must also refer to the kyphosis associated with osteomalacia; this form, however,

FIG. 56.—Faulty and Correct Position at the Piano. (Roth.)

is rarely seen purely in the sagittal plane and is ordinarily preceded by great pain.

The rachitic variety of round shoulders calls for anti-rachitic measures. The child should not be allowed to assume the upright position, but should be made to recline, as far as possible, on a good mattress. Nourishing food should be administered, the muscles of the thorax and of the limbs should be exercised. Cold bathing and rubbing are of value. For small children a gutta-percha splint shaped to the back and fitted with axilla straps, and a broad abdominal bandage is the most appropriate apparatus.

Older children require one or another of the many varieties of supporters. A suitable supporter must be provided with a pelvic band, and it should be constructed with two

vertical steel blades to extend up and down the back, as al with shoulder straps. Thus the required position is secure and the weakened muscles are suitably re-enforced. Staffel apparatus is an excellent one. Heather Bigg and others hav devised supporters which only control the shoulders and th pelvis, leaving the thorax and abdomen free.

Banning's apparatus (Figs. 57 and 60) takes purchase a the lower abdominal region through a pad, *A*. Two stee springs (*C*) pass over the iliac crests and obtain purchase a the gluteal region through two pads, *B*.

Fig. 57.—Banning's Truss.

Fig. 58.

All supporters which are not fitted with a pelvic band and those which, like the well-known Bouvier, simply extend between the shoulders, are worthless.

Corsets, lightly constructed and fitted with steel blades, are also suitable for the treatment of round shoulders, especially when straps for holding back the shoulders and neck are adapted to them. Nyrop's spring supporter consists of a pelvic band to which a posterior steel blade is attached. Above, this blade is connected with a cross-blade which carries the shoulder straps (Figs. 59 and 61). This supporter corrects the habitual anteflexion of the spinal column, and it is especially

valuable in that it does not compress the thorax, is light in weight and may be worn under the clothing without attract-

Fig. 59.—Nyrop's Supporter.

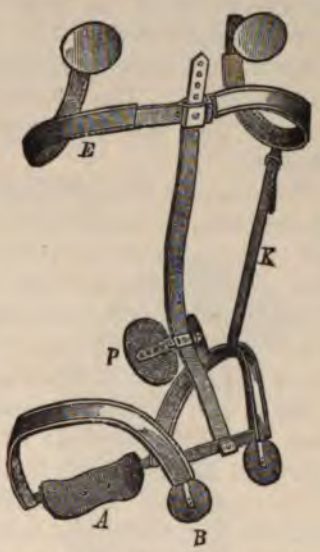


Fig. 60.—Banning's Supporter.

ing attention. The Stillman apparatus also fulfills well the indications, and it takes purchase on the sacrum.

The pathological variety of kyphosis is the result of caries of the vertebræ, as a rule, dependent on tubercular osteitis. The deformity is characterized by an angle in the spinal column, the concavity of which is forward. One or more of the spinous processes of the vertebræ project backward forming a hump. The bones are softened by the granular osteomyelitis, and the anterior portion of the bodies of the vertebræ sink downward under the weight of the body.

Fig. 61.—Nyrop's Supporter.

This disease was first described in 1783 by P. Pott, and it therefore bears his name, although the affection was known to Hippocrates, Galen, and others, and although Delpech and especially Nélaton had recognized its tubercular nature.

Although American writers (Bauer, Sayre, Owen, and

others) are inclined to consider trauma an etiological factor, even though the history yields no clue in regard to such an occurrence, there can be no doubt but that the affection occurs spontaneously without any determinable cause, and that weak children and those predisposed to tuberculosis are apt to become affected. The disease unquestionably develops in a tubercular soil, and can only exceptionally be traced to other diseases.

The disease may develop at any time of life, but it chiefly affects children from two to six years old. The infant is not apt to be affected and the disease is rare during the first year. After fifteen years it is very exceptionally met with. Nebel found only twenty-eight instances above fifteen years out of 225 cases. It may, however, develop in adults and even old age is not absolutely exempt.

Boys are, in general, much more likely to become affected than girls. Nebel[3] out of fifty-four cases found thirty-one male and twenty-three female.

In regard to the frequency of caries of the vertebral column we can offer the following statistical data: In 52,256 records of autopsies Menzel[4] found 702 cases of caries of the vertebræ and 238 cases of caries of the knee-joint; Nebel found 82 instances in 1,957 autopsies; Billroth states the percentage of vertebral caries as 35; König claims that this percentage is far too low.

As to the frequency of the disease in one or another part of the spinal column statements are very different. According to Billroth, the vertebræ are most frequently affected in the following order: the sixth dorsal vertebra, the second cervical, the fifth, seventh and eighth dorsal, the third cervical, the third, fourth, ninth and tenth dorsal, and next the fourth lumbar vertebra. According to Hüter[5] the eleventh and twelfth dorsal are most frequently diseased, and next the first lumbar vertebra. Nebel also states that the lumbar portion of the spine is most frequently diseased. In 183 cases Parker[6] found the cervical vertebræ diseased nine times, the dorsal eighty-two times, the dorso-lumbar twenty-one times, the lumbo-sacral thirty-seven times.

Kyphosis, then, in the vast majority of cases, is the result of a tubercular affection of the bones which either begins as a granular myelitis (granulation tuberculosis)[7] at one or more

places, thence spreads and leads to sinking of the affected portions under the weight of the body, or else it begins as a tubercular infiltration of the bone substance leading to a purulent osteitis. This latter form was described by Delpech and Nélaton under the name of tuberculosis of the bones. On section of the affected portion of bone it is found to be infiltrated with a yellow material. The surrounding bone tissue is hyperæmic and the two portions are separated only by a thin layer of tubercular granulations. (Fig. 62.)

FIG. 62.—Osteitis Caseosa (Tuberculosa) of a Vertebra. (Cross-section.)

FIG. 63.—Spinal Column of a 4½-year old Child. Caries of the Tenth Dorsal and of the Second Lumbar Vertebra. *ab*, Carious remnant of the vertebra; *cd*, Kyphosis; *e*, Last rib. (After Paul.)

The affected bone may speedily break down, or else the tubercular sequestrum may remain latent for years, being surrounded by granulations. The inter-articular cartilage may become involved through extension of the granulation process, or else suppuration and necrosis may start in the cartilage and the process may thence extend to the adjacent vertebra.

Primary fungous inflammation of the vertebral joints is very exceptionally met with, and then ordinarily in the verte-

bræ of the neck leading to displacement in this region. When the upper cervical vertebræ are affected dislocation of the diseased joint, in particular the first, may lead to sudden death from pressure on the medulla.

The suppurative process is rarely widely disseminated superficially. In such instances the periosteum is undermined and many of the vertebræ are eroded, as it were, on the surface. Such is the case in actinomykosis. Usually the suppuration is more central. In an unexplained manner the process invades one or another neighboring vertebra. A cavity filled with granulations or with detritus is formed at the diseased locality, and when the bone substance surrounding this cavity is no longer able to withstand the pressure, the vertebra sinks in, its spinous process projecting backward. This is the beginning of the hump, which is of course the more marked the more extensive the caries of the body of the vertebra. Occasionally the epiphysis is destroyed and the process involves the apophyses and vertebral arches. Such an extension, however, is rare.

If the affected vertebra be macerated, then, after the granulations have been removed, we may readily inspect the cavity in the bone. The vertebra looks as though it were worm-eaten. Frequently only remnants of one or more vertebræ are left (Figs. 64 and 65), so that the number affected can only be estimated by counting the spinous processes. It is readily apparent why the softened body of the vertebra cannot withstand the pressure to which it is exposed. The point of union of the spinous processes remaining intact, the anterior portion of the affected vertebra sinks forward.

Without question there occur cases of spontaneous cure of caries of the vertebral column, especially where the process is superficial rather than deep. The pathological granulations are replaced by healthy; these latter ossify and lead to a species of bony union. In other cases the formation of a marked gibbus is counterbalanced as follows: The inflammatory process leads to the formation of osteophytes in the neighborhood. These coalesce and bridge over the diseased portion of the spinal column, thus yielding an efficient support and preventing additional deformity.

In the vast majority of cases, however, an abscess results from the extension of the destructive process. The pus infil-

trates the neighboring parts, and eventually a large abscess cavity is formed. Since the anterior vertebral ligaments constitute a barrier in front, the pus sinks downward through the loose cellular tissue until it appears at certain determined spots as the so-called cold abscess. This abscess gradually increases in size; it may remain latent for long, or it may quickly spread toward the skin, and, if the knife is not resorted to, it breaks externally, the air enters the large cavity which is covered with the fibrinous, so-called pyogenic membrane, and the patient may speedily die of sepsis. According to Taylor abscesses develop in 14 per cent. of cases of kyphosis.

König and Henke,[8] Soltmann and others, have pointed out how in the dissemination of the pus to form an abscess the loose cellular tissue offers no obstacle while

FIG. 64.—An Instance of Cure of Caries of Cervical Vertebræ. Three Vertebræ are merged into one. Slight amount of Interstitial Tissue remaining.

FIG. 65.—Macerated Specimen. Entire Destruction of a Dorsal Vertebra. Ultimate Anchylosis of the Apophyses.

the fascia and the aponeuroses do. The abscess rarely breaks through the latter. The pus sinks by gravity in the direction of the least resistance and it points at certain characteristic places. Pus from caries of the upper cervical vertebræ gravitates along the pharynx. It pushes the mucous membrane forward and it forms what is known as the retropharyngeal abscess. Such an abscess is of special importance, since it may readily lead to dyspnœa and dysphagia. Its sudden rupture may cause death.

Pus from the dorsal vertebræ, as a rule, gravitates through

the aortic hiatus into the abdominal cavity. It then follows the course of the psoas muscle, occasionally leading to suppuration of the muscle. It passes under Poupart's ligament through the inguinal ring and points in the upper part of the thigh, as the so-called ileo-femoral abscess. Exceptionally the pus travels along the psoas muscle into the abdominal wall and points in the inguinal region (Fig. 70 *a*), or else it sinks into the scrotum and there simulates a hydrocele or an inguinal hernia.

In other instances the pus passes along the iliac fossa into the cavity of the pelvis and travels outwardly along the ischi-

Fig. 66.—Purulent Remnants in the Middle Dorsal Vertebræ. Notwithstanding the marked kyphosis the spinal cord was not compressed.

Fig. 67.—Complete Bony Union in a case of Vertebral Caries. Three dorsal vertebræ fused together. (Reduced ⅓.)

atic muscle through the major ischiatic foramen. The gluteal fold becomes effaced, a tumor forms in this region and an ischio-femoral abscess exists. Seeing that flexion of the hip may be associated with this abscess coxitis is simulated.

Exceptionally pus from the cervical and upper dorsal vertebræ travels down and points in the axilla, or else it travels along the ribs outside of the pleura pointing in the thoracic walls. Or, further, it penetrates between the muscles of the back and presents there as a fluctuating tumor. Rarely does the pus penetrate the pleura and form an empyema.

These abscesses may also rupture into the intestine—into the duodenum, the colon, the rectum, or into the bladder.

Owen has directed attention to the fact that *fistula in ano* may follow from rupture of an abscess resulting from vertebral caries.

In kyphotic patients there are also present disturbances from the side of the muscular system. So-called counter-curvatures are developed, especially a lordotic curve of the cervical vertebræ. Gradually this curve becomes a permanent one and the position of the head characteristic of severe instances of kyphosis results. When the seat of the affection is in the dorsal region the framework of the thorax collapses, as it were, through the sinking together of the vertebræ. Occasionally the ribs approximate one another so closely as to come into contact. In disease of the lumbar region the lower ribs sometimes project over the pelvis or sink down into the iliac fossa. In general the ribs are lifted upward, the sternum projects like a keel (chicken-breast), the vertical diameter of the thorax is markedly lessened and congestive and pressure symptoms are in consequence present.

The concurrent symptoms from the side of the spinal system are above all of importance. Frequently the nerve bundles, which pass through the intervertebral foramen, seeing that they lie imbedded in infiltrated or hyperæmic or suppurating tissue, take part in the disease process. It is often astonishing how the spinal cord escapes alteration notwithstanding kyphosis of high degree. As a rule the membranes of the cord near the diseased region are thickened and callous. Peripachymeningitis results. The pus may perforate into the spinal canal, or the disease may extend to the substance of the cord itself through implication of the membranes.

In a certain proportion of cases, especially when the hump forms quickly, the spinal cord suffers directly from compression. A so-called compression myelitis develops, and the degeneration may extend above and below (Turk), giving rise to the so-called secondary degeneration. This degeneration is characterized by disease of the posterior fibres above the spot of softening, and of the lateral fibres, in particular, below. Macroscopically this disease is evidenced in the fresh specimen by a grayish, transparent, pale yellow appearance, and microscopically, after staining, we may find fatty degeneration of the nerve bundles and interstitial increase of the cellular tissue.

Exceptionally the spinal cord is compressed by the projection of an abscess inward.

The symptoms of implication of the spinal cord may be varied, such as slight contractures, paræsthesiæ, pareses, even complete paralysis. The paraplegia will be extensive according to the seat of the disease, and cystitis, decubitus and other affections may be the sequelæ. The reflex symptoms are usually greatly exaggerated. The triceps-reflex is often obtainable.

A further important sequela of kyphosis, when the seat of the disease is in the lumbar region, is alteration in the shape of the pelvis. For information in regard to the kyphotic pelvis we must refer the reader to text-books on obstetrics.[9]

Fig. 68.—Traumatic Dorso-lumbar Kyphosis in a Man aged 30.

More infrequently still than the tuberculosis of the bones (spondylitis) of which we have spoken, may tumors (sarcoma, carcinoma) of the spinal column, gummous osteitis accompanying general syphilis, and possibly actinomycotic changes lead to kyphosis, or else the disease may develop more gradually as the result of trauma (Fig. 68). Fracture, associated with comminution of the body of the vertebra, the processes remaining intact, may eventuate in kyphosis.

As regards the symptomatology of the disease, the premonitory signs are characterized by the individual becoming readily tired, by intercostal and lumbar neuralgias, by stiffness of the vertebral column in walking or other motions, etc.; often the child simply shows a disinclination to play, has an anxious look, and is careful not to move the vertebral column in ascending stairs, in jumping, etc. The most marked symptoms are the deformity, the formation of the hump, the accessory phenomena from the side of the spinal system and the gravity abscesses.

Often the sudden crying out of the child during the night, or grinding of the teeth, or a deep-lying pain in the epigas-

trium, are the first symptoms leading us to suspect disease of the vertebral column. Then the rubbing of the column with a hot sponge (Copeland) may reveal sensitiveness of the affected vertebra, or else pressure on the spinous processes may result in causing marked pain. Occasionally the formation of the gibbus is evidenced by projection of the spinous process of the diseased vertebra when the patient bends forward. The deformity is especially apparent in the dorsal region as a projecting knob which gradually becomes evident and attracts the attention of the parents. Very rarely the deformity appears suddenly without premonition, and in these acute cases the spinal symptoms in particular predominate. Such symptoms are often not marked to a surprising extent in instances of long forming, although aggravated kyphosis. The motor nervous system is naturally less severely implicated, and, according to the seat and the extension of the disease, we may determine only slight paresis of certain muscle groups, a certain difficulty in motion, or entire paraplegia or total paralysis of the parts lying below the disease centre. Weakness of the sphincters up to complete paralysis of the rectum and bladder frequently form the sad accompaniments of aggravated kyphosis.

Fig. 69.—Fixation of the Vertebral Column in Bending.

When there exists a suspicion of caries of the spine the child should be entirely unclothed and then examined. It is of the greatest possible importance to make an early diagnosis, for thus the extension of the disease may be prevented.

Parasthesias of slight degree, sensation of constriction, anæsthetic zones, weakness, etc., such symptoms should direct the attention of the physician to the spinal column, especially if, in addition, the subject becomes readily tired and is averse to movements. We may often obtain an absolute diagnostic symptom of disease of the vertebræ by making the child bend forward and noting how the act is performed with the spinal column held rigid (Fig. 69), and, next, how the erect

position is reassumed purely by extension of the lower extremities. Often these patients rest their arms on the thighs in order to lessen pressure on the diseased surface, or else they avoid standing or walking as much as possible.

In children, as a rule, the disease progresses rapidly to the formation of the gibbus, while in adults the affection frequently exists for a long time without angular kyphosis, and the disease of the vertebræ may be readily mistaken for other affections. In aggravated instances with marked gibbus, or where abscesses or symptoms from the side of the cord are present, the diagnosis offers no difficulties, while in the beginning the disease may be mistaken for coxitis, or for hysterical

FIGS. 70 and 70 a.—Lumbar Kyphosis. Front and Profile View. Beginning Abcess above the Crest of the Ilium.

manifestations, or for disease of the cord, etc. This holds true in particular for adults, where the affection is apt to progress slowly before the characteristic deformity appears. In case of coxitis it should be noted that the contracture is not a simple one, as in that accompanying spondylitis, but it is combined either with abduction and outward rotation of the limb or else with adduction and inward rotation.

As regards disease of the vertebræ of the neck the deformity, as a rule, appears somewhat differently. Often we can only determine a thickening on one side of the neck, a bending or drawing of the head. Eventually the abscess appears laterally in front of the cucullaris muscle and it ordinarily breaks through the supra-clavicular fossa.

Kyphosis in the neighborhood of the last vertebra of the neck may readily be confounded with the normal projection of the *vertebra prominens.* Frequently torsion of the neck toward the healthy side results. (Torticollis oss.)

In order to determine beginning abscess formation it is requisite to look for the following symptoms: Deep-lying neuralgic pains, pain on pressure, swelling, distention of the veins, œdema, etc., in the affected region, and, in particular, we must

FIG. 71.—Kyphosis of the Upper Dorsal Vertebræ.

FIG. 72.—Kyphosis in the Lower Cervical Vertebral Region. Wing-like Backward Projection of the Scapulæ.

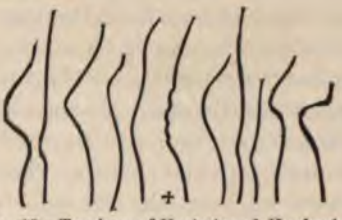


FIG. 73.—Tracings of Varieties of Kyphosis. (N. Smith.)

examine the iliac fossæ when the patient is in the dorso-recumbent position with flexed limbs.

It is often essential to obtain a tracing of the kyphotic projection, in order to follow the successive changes. For this purpose a strip of lead molded over the vertebral column will answer, or we may use one or another of the apparatuses which will be described under the subject of skoliosis.

The progress of the disease leading to kyphosis is usually chronic and rarely acute or sub-acute. Where the affection runs an acute course it is associated with febrile phenomena

and may end in death before the deformity appears. In children, as we have stated, the progress is ordinarily more acute and in a few weeks a very marked gibbus may form. In adults years may elapse and numerous abscesses may form before the appearance of the characteristic deformity. We may frequently differentiate a number of stages in the progress of the affection: 1. The stage of onset where the symptoms are not specially marked; 2. The stage of characteristic gibbus; 3. The stage of suppuration and of paralysis. The disease does not always progress to the latter stage. In many instances, after two to three years' course, we rather find the vertebra again solid through a species of ossification, and a cure results. This may happen at any time, even after abscesses have formed. Even spontaneous resorption of abscesses has been noted. This, however, is infrequently the case.

The prognosis of the disease is, in general, unfavorable. The old saying of Hippocrates "*qui gibbosi ex asthmate et tussi fiunt, ante pubertate moriunter,*" refers to the high mortality rate from tuberculosis of kyphotic children (Busch), and it is certainly true that a large proportion of those affected succumb to miliary tuberculosis, amyloid degeneration, etc., and that even where the local process becomes arrested there remains a tendency to emphysema and above all to lung and to heart diseases, and therefore the affected individuals rarely reach middle age. Formerly the abscesses often endangered life and true enough the modern treatment of these accumulations of pus has bettered the prognosis a trifle; the symptoms, however, from the side of the spinal cord, always modify the prognosis, for, after an interval of many years, we often witness the development of paralysis, and when once symptoms of compression and of paralyses have appeared (particularly from the side of the bladder and of the rectum) the clinical picture becomes a very sad one, decubitus, hypostases, etc., soon form and end the scene. The higher the seat of the disease, the more extensive the process, the more unfavorable the prognosis, which, of course, also depends on the general constitutional strength, on the concurrence of affections of the lungs, etc. As regards the subject of treatment we must differentiate the general from the special mechanical.

It should be the endeavor to re-enforce the general health

as far as possible by means of suitable food, preparations of iron, cod-liver oil, sea-baths, fresh air and sunlight.

In an early period of the affection cold applications to the spine by means of ice-bags (Chapman), are very valuable, as proved by Esmarch's and Eulenburg's experience. Hueter recommends the injection of carbolic acid in the neighborhood of the diseased vertebra or deep injections of a solution of corrosive sublimate. It was formerly the custom to depend to a great extent on derivatives (Pott, Rust). To-day these agents have been rejected, although latterly fly-blisters have been extolled by a number of gentlemen, for example by Busch.

The chief indication in the treatment of caries of the vertebræ is the fixation of the spinal column and the removal of pressure from the anterior portion of the vertebra, that is to say we must seek by means of rest to prevent irritation of the affected part, and our aim must also be as far as possible to remove pressure from it. It is in these directions that modern practice has chiefly excelled, and especially in that attempts at forcibly straightening the spinal column have been condemned.

Formerly, the chief indications were deemed to be the keeping of the patient in the horizontal position and the forbidding of the assumption under any pretext of the erect posture (Eulenburg, Baum, Noble Smith, and others). Bauer, for instance, recommended the horizontal position on a water bed; others have commended keeping the patient lying on the abdomen on a suitable bed—the prone system of the English (Harrison, Bampfield, Knorr). Others have extolled the lateral position. Noble Smith[10] claims that the advantage of the abdomino-recumbent position is that pressure is thus taken from the diseased part and the unfavorable traction of the muscles on the anterior portion of the column is prevented. He does not believe that there is thus risk of the pus gravitating forward. Such methods, however, cannot be carried out without injury to the general health, and in any event harm may result from uncontrollable movements of the patient.

In a proportion of the cases, especially in infants, the dorso-recumbent position on a good hair mattress must be considered the best procedure. Apparatus (Volkman, Kappeler) for preventing involuntary movements on the part of the patients, a matter of the greatest possible importance where the dis-

ease affects the vertebræ of the neck, can certainly only be used in children who are old enough to be taught the necessity of restraint. Such apparatus may act either through counter-extension by weights or through elastic traction. The patient is placed horizontally on a hard mattress. Extension is obtained by the following mechanism: To a collar around the patient's neck a stout string is attached which passes over a roller on the top of the bed and carries a weight of from four to six pounds. The weight of the body yields the counter-extension. In case of caries in the dorsal or lumbar region traction may also be made from the axillæ.

Where the disease is located in the middle portion of the spinal column Rauchfuss' suspension girdle[11] may be used. By means of it pressure is removed from the diseased portion, and the requisite degree of traction is readily obtained by lowering or raising the girdle. This girdle is drawn tightly transversely over the bed under the affected portion of the spine and direct pressure on the gibbus is avoided.

For the median portions of the spinal column it is possible to utilize the weight of the body for purposes of distraction through Rauchfuss' suspensory belt. This is a broad belt stretched across the bed, which can be applied with special facility to the ordinary children's slat beds, and on which the affected portion rests; the amount of stretching can be easily regulated by higher or lower suspension of the belt. Pressure on the gibbus can be readily avoided by cutting out a corresponding segment from the belt. The difficulty of fastening the child sufficiently to the belt, which seems to reduce the value of the apparatus in the eyes of some (Nebel, Koenig), has been overcome by Schildbach's modification.[12]

This belt ($1\frac{1}{2}$ to 3 inches broad according to the age) is fastened to the sides of the bed and hangs in a curve. Schildbach attached to its two ascending portions two cross strips, the ends of which are fastened over the body of the child, thus fixing it, while two lateral cushions relieve the pressure on the gibbus.

Koenig employed for fixation a close-fitting jacket with sleeves and thigh-pieces which are fastened to the dorsal belt.

Reyher recommended a broader belt (7 inches), together with shoulder and perineal belts for fixation.

Mass[13] devised a simple and convenient way of relieving

weight and exerting extension by placing the patient on roll-pillows.

By causing the patient to recline over suspensory belts or rolls, we may usually attain rapid relief from pain and we

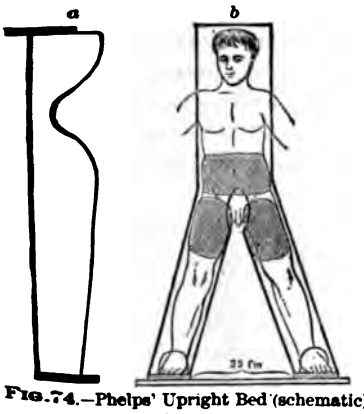


FIG. 74.—Phelps' Upright Bed (schematic); *a*, Lateral; *b*, Front View.

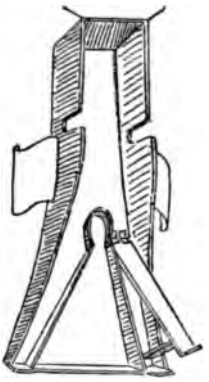


FIG. 75.—Upright Bed with Movable Leg-rests.

FIG. 76.—Upright Bed containing patient.

may exert a favorable influence on the deformity. These procedures are simple and, in tractable patients, are very effective.

One application of the principle of extension which can always be easily and cheaply resorted to, is the upright bed

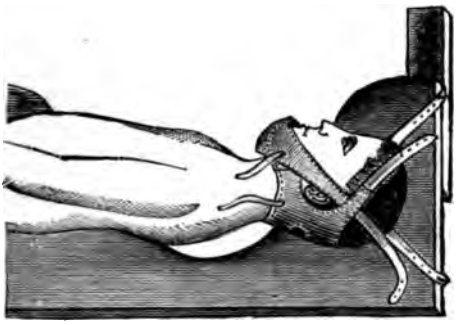


FIG. 77.—Fastening of the Head to the Upper End. (After Nebel.)

devised by Phelps (Figs. 74 to 77), and it is an apparatus of great value in infants, particularly for paralytic cases, and for those where there exists marked curvature.

By measuring or by making an outline drawing of the child with legs spread apart, we may have constructed a wooden case with openings for the arms (Fig. 75) and for defecation;

the foot-board must be about 5½ inches high, and places for the heels are cut out, while the top of the bed is only closed at the posterior half by means of a slat. The case is then padded on both sides and especially across the middle with jute cushions; the padding (Fig. 74) is covered with waterproof material, the child is laid into the case and fastened with flannel roller bandages; the head is covered by an ordinary cap or rests in Glisson's slings, the straps of which are hung to nails on the lateral wall of the case. When the case is lifted and placed nearly or quite upright, the child is, as it were, suspended partially by the head.

As a rule, children with spinal caries are bedded afresh about once a week; the legs should be bandaged anew every day and be subjected to passive motion.

Portable kyphosis machines, in their simplest form, consisted of fixation by dorsal splints (the old cross of Heister) or of firm dorsal shields to which the pelvis and thorax were fastened, as in the wire cuirass of Bauer, the Volkmann half-cuirass of rubber, etc.

At an early period apparatus was devised which supported the spinal column through axilla crutches or braces; soon, in order to obtain vertical extension, Le Vacher[14] added a suspender for the head to the supporting apparatus (an appliance which, after having long been condemned as dangerous, has now again found general application in the shape of Sayre's jury-mast). These extension bandages with dorsal splints and Le Vacher's suspender for the head for a long time represented the chief means of treatment.

Then Taylor pointed out that a bent stick, which may be taken to represent the kyphotic spine, can be straightened not by extension, but more appropriately by being bent over a fulcrum placed at the point of flexion; and he applied this principle by means of a bilateral padded splint, acting as a lever, and casing dorsal flexion of the anteriorly curved spine.

It soon became evident, however, that Taylor's machine, which will be more fully described below, acted mainly as an immobilizing dorsal splint (Hueter, Vogt[15]), that the correction was only apparent, and P. Vogt noted in numerous children that the apparent over-correction of the anterior inclination was due solely to a lordotic flexion of the neighboring spinal segments, while the kyphosis persisted unaltered. He

therefore modified Taylor's apparatus by the addition of means for the removal of pressure from the spinal column. He effected this by adding lateral arms with axilla crutches to the splint at the level of the shoulders (occasionally also adapting lateral braces to the pelvic belt), and for the support of the head he added a steel collar covered with leather and united to an extension from the dorsal splint.

All these appliances must be carefully watched; they can only be made by a mechanic, their construction takes time, and they are expensive. It is apparent, therefore, that a

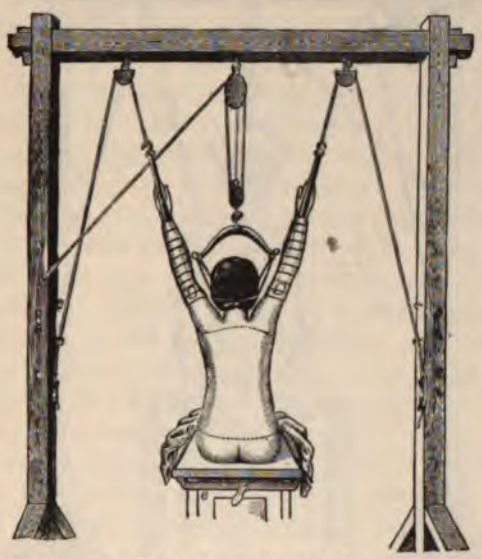


FIG. 78.—Suspension for the Application of a Corset. (After Beely.)

method applicable to the routine needs of every physician was bound to find rapid and general recognition, and for this reason Sayre's method of treatment by the corset and suspension spread quickly and proved valuable everywhere. Reports from numerous clinics (Esmarch, Madelung, Nebel, etc.,) certify that the plaster-jacket method of treatment is one of the handiest, most certain, and cheapest means of fixation. By an early application of the plaster jacket it is usually possible to forestall the occurrence of permanent deformity, and frequently to prevent the formation of gravitation abscesses (Nebel [16]). By means of this method we undoubtedly give the

patient great relief, mitigate his pains, and frequently effect a cure.

Sayre's method can be employed for caries at almost any point of the spine, and neither gravitation abscesses nor bed-sores are contra-indications. It is hardly possible to lay too much stress upon the fact that thereby we do not aim at *brisement forcé*, or obliteration of the kyphosis, but that we try to circumvent the injurious influence of weight and mus-

FIG. 79.—Suspension for the Application of a Plaster Bandage.

cular traction by careful, gentle suspension, simply sufficient to lessen the pressure on the affected parts, the toes never leaving the ground. Sayre lays stress on the point that the suspension must be gradual, and that we must never go beyond the point at which the patient feels entirely free from pain. The plaster jacket is applied as follows:

Everything necessary for the plaster dressing having been prepared (good modelling plaster, starched gauze bandages into the meshes of which plaster has been rubbed, dishes with warm and cold water, cotton, etc.) and the patient having

been dressed in a seamless stockinet jacket, the head is fastened in Glisson's suspender, due care being taken that the chin strap does not slip, the body being at the same time supported by axillary rings (Fig. 78) in Sayre's tripod (or by a hook in the ceiling) by means of pulleys, so that the patient still touches the floor with the tips of the toes. Then we insert under the stockinet jacket, which is tied over the shoulders, a pad of wadding ("dinner pad") over the region of the stomach; the mammary glands and the crests of the ilium are protected by pads, and small felt bolsters are placed on both sides of the gibbus (Madelung). Then, commencing at the pelvis and winding upward until we reach the axillæ, the trunk is surrounded with plaster bandages, avoiding folds. A fresh bandage is placed into the water to soak only after removal of the preceding one. While bandaging, the physician stands preferably behind the patient, while one assistant kneels in front, holding the legs to prevent rotation, and another at the side holds the cord and hands the moistened bandages.

Usually it is sufficient for the corset to extend upward a little higher than the nipples, covering half the shoulder-blades. In case of dorsal or cervical kyphoses, the jury-mast must be included in the plaster dressing. (In children, as a rule, five to six plaster bandages about 13 feet in length and 3¾ inches in width will suffice; occasionally, the back of the bandage may be strengthened by chips of veneer, etc.)

The patient must not be taken out of the suspensory apparatus and laid horizontally on a mattress until the plaster has set, and then the dinner pad is removed and the dressing is cut out somewhat at the axillæ, etc., if necessary.

The application of the plaster jacket with the patient in the horizontal position, as recommended by Walter, Willet, and others, has been tried more especially by Petersen;[17] the head and pelvis of the reclining patient are supported, suspension being obtained by a bandage carried around the gibbus, and in this position the plaster dressing is applied.

When no special indication arises for its removal, the jacket may be worn for from three to six months. If the jacket is constructed so that it may be removed at will, its effectiveness is partially nullified, and this is allowable only for slight cases near recovery. The removal of the jacket is greatly facilitated by including in the front of the dressing a strip of

leather, which is divided after the plaster has set, and if perforated with holes on both sides can be made to lace. Roberts added anterior metal clamps for the purpose of removal (Fig. 80).

Fig. 80.—Roberts' Corset with Central Clamps.

A number of modifications aim at making the plaster jacket in several layers and to include extension apparatus (Stillman, Wyeth, etc.). Wyeth[18] recommended that the jacket be made in two pieces, with extension screws passing through nuts fastened in the dressing, thus allowing separation, the intervening part (gibbus) being bound moderately tight with a roller bandage. During the night the posterior rod can be removed, the two lateral sufficing when the patient is in the horizontal position (Fig. 81).

Similarly, Roberts[19] has devised a means of extension in connection with a double plaster jacket, including four supporting clasps of perforated sheet copper (Fig. 9); a corresponding number of iron rods with screws and spiral springs allow of gradua-

Fig. 81.—Wyeth's Double Corset with Extension Rods.

tion of the spring pressure. This modification can also be used for the correction of a co-existing lateral deviation, by connecting two of the iron rods by a rubber cord or adding another clamp on the side opposite the deviation, the rubber cord passing along the outer side of the corresponding extremity and being fastened to the shoe (Fig. 82).

For cervical kyphosis, in particular, the ambulant apparatus requires a number of additions, in order to relieve pressure

FIG. 82.

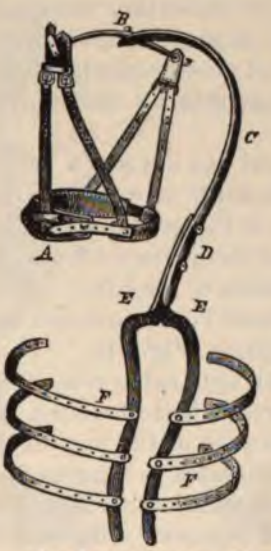


FIG. 83.—Jury-mast.

FIG. 84.—Jury-mast. (After Nebel).

and to provide extension; this has been effected by a number of appliances included in the plaster jacket, etc., thus, for instance, in Berger's method, reported from Thiersch's clinic, "the bridge plaster dressing" consists in a plaster jacket inclosing the shoulders, from which extend two lateral iron bands with proper curve, which are fastened in a plaster dressing applied around the occiput and forehead. The jury-mast (Fig. 83) consists of a two-tined fork, *E*, of soft iron, which carries above (corresponding to the handle) a movable, solid, more unyielding rod, *C*, which projects over the head

and in front to about a line uniting both ears; to this is fastened a cross-piece which can be rotated around a rivet, *B*, and which carries at its two ends small hooks for the suspension of the head-piece, *A*. The iron blades constituting the prongs of the fork are curved to fit the back, and are provided at the sides with two or three narrow brass hoops, *F*, which almost completely encircle the thorax, and are perforated like a grater, so as to give hold to the plaster bandage.

In using the jury-mast, the patient is first wrapped in the usual manner with a few turns of plaster bandage, care being taken that the bandage surrounds the thorax smoothly; the jury-mast, properly surmounting the head and in the sagittal plane, is next placed in position, and the apparatus is fastened by additional turns of plaster bandage, the assistant carefully moulding the bandage into all the depressions caused by the apparatus.

Morris (New York) has devised a very cheap substitute for the jury-mast. It is made of iron wire the thickness of a lead pencil. This is bent to the proper shape, and the parallel wires are fastened at equal distances by brass bands soldered on and reinforced at the points of greatest curvature (thus securing elasticity), small square hooks soldered on serving for the suspension of the head-piece (Fig. 84).

In regard to other apparatus resembling the jury-mast we may mention Roberts' elastic traction head-rest, which does away with the annoyance of the jury-mast extending over the head, which is objectionable to many. It consists of an upper cervico-mental collar, with metal clamp under the chin, so that it can be applied and removed with ease. To this the body-piece is fastened by means of lateral coiled springs and a hinge-joint. This trunk-piece can be moved longitudinally and placed at any desired point in the sagittal plane by an endless screw. The lower forked part of the apparatus is inclosed in the usual manner in the plaster dressing.

W. Pye,[20] in many cases of kyphosis of the upper dorsal vertebræ, incloses in the plaster dressing a dorsal splint instead of the jury-mast; this splint is forked below, so as to avoid pressure on the diseased parts. Above, it reaches only to the occiput, and at its free upper extremity it bears two transverse rods (one at the upper end, one at the height of the first dorsal vertebra). To the former arm-slings are at-

tached, to the latter slings of stout material for the thorax and abdomen, which are included in the plaster dressing and thus counteract the tendency to bend forward.

Although there is no doubt that the plaster dressing is one of our most important therapeutic agents, on account of its cheapness, facility of construction, slight weight, and non-interference with taking exercise, we must remember the disadvantages of the method, pointed out, for example, by Smith

FIG. 85.—W. Pye's Modified Jury-mast for Upper Dorsal Kyphosis.

FIG. 85 a.—The Same Apparatus after Fastening the Slings.

—*viz.*, the impossibility of watching the morbid process and of determining when it is necessary to remove the jacket; further, the facts that perspiration is interfered with, that vermin may lodge in the bandage, and especially the fact that it interferes with the development of the thorax when it is worn several months. For these reasons the exclusive use of the method has been largely abandoned.

The material from which the jacket may be constructed has been modified. In order to secure greater durability, the

jacket has been made of silicate of soda—a method recommended among others, especially by Wolff, Fowler,[21] Kölliker,[22] and Witzel. The silicate of soda is preferable to any other material on account of its lightness, its durability and cheapness, and particularly because the jackets can easily be made in a removable form. According to Kölliker, the silicate of soda should be applied with the patient suspended, the heels slightly raised from the ground, the traction acting mainly on the head; flannel bandages are first applied, then four to six layers of silicate bandages, which must not be too moist, lest the flannel become saturated. Strips of veneer are included in the dressing at the upper and lower edges, in each axillary line, and laterally at the spinous processes to reinforce the bandage. A temporary plaster dressing consisting of three to four bandages should be applied over all, to keep the silicate bandage in position until it has hardened (two to three days). The patient must remain suspended until the plaster has set (Wolff).

For cervical spondylitis, silicate of soda bandages surrounding head, neck, and trunk, and fashioned over a plaster cast, have been much employed in Schonbörn's clinic (Falkson[23]). They are made to lace by covering the edges with strips of linen having hooks sewed on, and are lined throughout with flannel.

Besides plaster of Paris and silicate of soda bandages for spinal deformities, use may be made also of simple starch-paste bandages with pasteboard shaped to fit the back, and saturated with shellac, and strengthened by pieces of linen.[24] The old and now almost obsolete glue dressings for making soft corsets with firm dorsal shields can be used to advantage, especially for poor patients, being cheap and durable, and the necessary material being everywhere obtainable.

Smith,[25] Braat, and Karewski[26] employ jackets made of woven wire shaped over the patient's body or a plaster model; they are tinned, to preserve them against rusting, and the jury-mast can easily be added to them. They possess greater durability and cheapness than the other appliances, and they can be used for cases of inferior lumbar kyphosis, where the patients are confined to the bed, by adapting splints reaching to the knees and by leaving openings for urination and defecation (Karewski).

Touvers[27] and others recommend a leather jacket shaped

over a cast, to which a jury-mast can be readily applied and which may be made removable. Mathieu also employed leather (strengthened by flexible steel springs) for corsets shaped over casts, but they were too dear to find general application. H. Bigg's leather corset, however, with elastic material over the chest and abdomen and lined with soft leather, is a very durable apparatus, which gives suitable support and which does not interfere with respiration.

Fig. 86.—Owen's Stiff Leather Cuirass for Caries of the Cervical Vertebræ. *A*, Anterior; *B*, Posterior Plate; *A'*, Chin Piece; *B'*, Occipital Portion.

Fig. 87.—Cocking's Poroplastic Felt Jacket.

Owen, among others, employs in cervical spondylitis a stiff leather cuirass firmly encircling thorax, occiput, and chin, lined with soft leather, and fastened by straps and buckles (Fig. 86).

The value of plastic felt (according to Coking-Adams) for kyphosis was demonstrated mainly by Beely, Madelung, and P. Vogt; it is easy of application, and it can be formed into a cuirass which yields equally good fixation. The plastic felt can be applied after having been cut from a paper model. The heating necessary for moulding formerly made the application of a felt jacket somewhat difficult; but this is no longer

the case, since Bruns has taught us to saturate the felt on the body of the patient or to shape it from a model. The corset is cut from soft felt and then saturated or painted with an alcoholic shellac solution (nineteen ounces to one quart of alcohol). Two to three days are required for drying, in winter four to five, but it forms a very durable (three to six months) corset that can be easily removed and arranged for lacing.

Beely[28] has devised a very practical application of the felt jacket, which, if the necessary splints, rivets, etc., are at hand, can be readily constructed by any physician. (See Figs. 88 to 92.)

The patient is either suspended after Sayre's method, so

Fig. 88.

Fig. 89.

Fig. 90.

that the toes still touch the ground, or else he is seated and suspended by the head, with extended arms, and fastened by a belt transversely across the thighs (Fig. 78). Without padding, the circular plaster bandage is applied and is made just strong enough to keep its shape after it is removed. This bandage is cut open in front, removed, again closed by a plaster bandage and strengthened at the weak places. Then we may either use it as a model, or we may make a plaster cast by filling its interior. Over this plaster model we mould strong but soft felt ($\frac{1}{4}$ to $\frac{3}{8}$ of an inch thick). The margins must overlap somewhat, and where the felt does not adapt itself closely to the model elliptical pieces must be removed and the edges sewed together. The felt is next coated as far as the upper dorsal vertebræ or the mammæ with the alcoholic shellac

solution (5:7) until it is hard. In front, on each side of the mid-line, a space of from one to two inches, and above and below a space of from one-half to one inch must not be coated. Spaces for the arms and for the mammæ must be cut out, and the edges must not be coated with the shellac. After repeated coating and drying for several days, the jacket is removed from the model and is fitted to the patient in the dorsal decubitus over the ordinary undershirt.

Fig. 91 a.—Felt Jacket. (After Beely.)

On the front edges of the jacket are sewed two strips of leather, with button-holes or else two rows of strong hooks to serve for lacing, while one or two buckles with a belt (Fig. 88) are fitted below.

Fig. 91 b.—Felt Corset with Double Mast.

To the posterior surface of the dressing (Fig. 89) two somewhat elastic steel longitudinal splints are adjusted and two transverse splints firmly united by screws or rivets; the height to which they reach depends on the seat of the disease. In case of spondylitis of the cervical and upper dorsal vertebræ the two longitudinal splints are lengthened

above, brought somewhat to the side, and bent so that their upper ends project two to four inches above the vertex, slightly beyond the plane of the mastoid process, and more than the width of the head apart; these serve as jury-masts, to which are fastened by four straps a belt provided with an excavated chin-piece (Fig. 91). In this way it is possible to attain almost complete fixation of the head; and when the head is not fixed the apparatus can also be worn in the dorsal position. Carefully padded shoulder-pieces pass over the shoulders; in jackets of greater size we may further strengthen the sides by longitudinal splints, and the latter may be made to turn above the upper end of the felt jacket around a vertical axis and be rendered adjustable in any position by an apparatus similar to that in Taylor's machine. The spinal column is protected by being covered

Fig. 92.—Felt Jacket (after Beely), with Double Jury-mast.

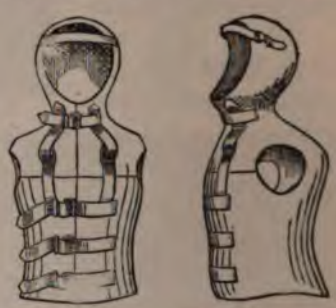


Fig. 93.—Walsham's Felt Cuirass for Cervical Kyphosis.

with a soft piece of felt (with a special incision for the gibbus) broad enough to cover the rivets.

At first the jacket should always be applied in the dorsal position and be laced below as tight as the patient can bear; above it should be loose enough to permit respiratory movements.

V. Horoch[29] states that there is a factory near Prague which makes a felt exactly like the English article at about half the price, thus rendering this mode of treatment accessible even to the poorest patients.

The felt cuirass recommended by Walsham,[30] which only

leaves the face free will always be open to objection on the score that it is too warm, even if provided with a number of openings.

Although all these jackets have the great advantage that they can be made by the physician himself and generally are not too dear, in some cases special advantages may be secured by more complicated contrivances which can only be made by a mechanic.

The majority of these consist of splints ascending along the back on both sides from a pelvic belt, or else of a firm dorsal shield (Fig. 94); many besides possess extensible axillary

FIG. 94.—Torticollis Apparatus. (After Langenbeck-Eulenburg.)

FIG. 95.—Spinal Supporting Corset. (After Nyrop.)

crutches, by means of which the collapsed trunk may be gradually raised. Especially in cases where a marked gibbus has not as yet formed may these corset-like appliances be of value, and they may be readily combined with a jury-mast for purposes of extension in high-seated spinal caries (Fig. 96). They resemble certain of the appliances recommended for torticollis.

A very useful apparatus, among others, is Nyrop's spring corset, represented in Fig. 95, in which the jury-mast, *c e*, with the head suspender, *f* (Fig. 96), may readily be inserted into the slides, *b c*, on the dorsal splints, *a*, while lateral springs, *d*, contribute to the firmness of the corset.

With reference to extension apparatus, Taylor, as has been stated, pointed out the necessity for dorsal flexion, and recommended retroflexion of the anteflexed spine against a pad placed under the site of curvature.

Taylor's apparatus[31] is one of the best known; it consists of a broad pelvic belt, from which arise two parallel steel double splints which do not touch the spinous processes and are broken by a joint at the point of the kyphosis, where they are well padded and should exert pressure. Their upper ends are fastened to the neck by two clasps and carry two axilla-

Fig. 96.—Jury-mast for Nyrop's Corset.

Fig. 97.

straps, which draw the shoulders backward. In case of cervical kyphosis a frame is added for the support of the head.

In order to avoid the unyielding pressure of Taylor's apparatus, Schildbach (Fig. 97) employs elastic steel dorsal splints, united above by a cross-piece. These splints are fastened to a stout pelvic belt, and carry buttons for the attachment of the axilla-straps and a broad abdominal leather belt.

In England, Chance's adaptable metal splint for caries of the dorsal and lumbar vertebræ has many adherents. It consists of two light metal splints ascending from a pelvic belt and bent according to the angle of the kyphosis. They reach to the height of the shoulders, where they are united to a plate from which the shoulder straps extend. At the angle

of the deformity, on each side of the hump, two pads are placed under the splints and exert leverage, relieving the pressure on the vertebræ, and drawing the trunk backward, while an abdominal belt prevents lordosis of the lower portion of the spine and fixes both the upper and the lower parts of the back in as straight a line as possible. This apparatus may be easily adapted to cervical caries by adding a dorsal rod and head band.

In all these apparatus for backward traction, the fatal objection lies in the fact that the deformity is increased when the patient bends forward, for which reason the material employed must be very strong. Stillman endeavored to utilize

FIGS. 98 a, 98 b, and 99.—Stillman's Lever Apparatus.

for these cases a species of lever power, by joining the short arm reaching to the kyphosis to a longer frame, the two being adjustable at any desired angle.

This apparatus for ordinary dorsal kyphosis is described as follows (Figs. 98, 99):

On both sides, along the line of the spinous processes, two padded splints ascend from a belt to the seat of the kyphosis (forming the short arm of the lever). The portion of the apparatus which exerts backward traction consists of a dorsal frame (representing the long arm of the lever) fastened to the pelvic belt and adjustable at any desired angle. When both arms of the lever are set at an angle and the dorsal frame (Fig. 98*b*) is drawn close, the short arm of the lever will exert pressure on the transverse processes by means of the pads

fastened above, and then, even when the upper part of the trunk is bent forward, there is no increase of the kyphosis

Fig. 100.

Fig. 101.

Fig. 102.

Fig. 103.

Stillman's Lever Apparatus with Jury-mast.

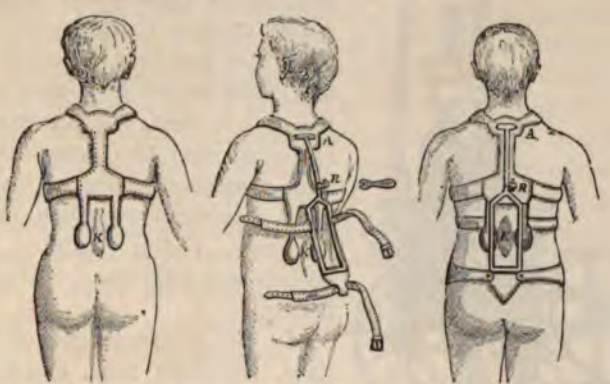
since the short arm of the lever will hinder flexion by forward pressure upon the gibbus. If well fastened, the apparatus

secures a higher grade of fixation than any other; it is light, and does not inconvenience the patient.

In apparatus for superior dorsal kyphosis the anterior straps are omitted, the long arm of the lever is fastened by axilla-straps with infra-clavicular pads (Fig. 100).

In the apparatus for kyphosis of the cervical or the first and second dorsal vertebræ a jury-mast must be added (Fig. 100), or else some other form of head-piece, by means of which the head can be fixed in any desired position (Fig. 102).

In the apparatus for caries of the lumbar (Fig. 103) or kyphosis of the lowest dorsal vertebra, the short arm of the lever would not be long enough to exert sufficient forward



Figs.—103 a, 103 b, and 103 c.—Stillman's Apparatus for Lumbar Kyphosis.

pressure on the gibbus, *k*; Stillman, therefore, altered the apparatus to meet this objection. The base, *A*, rests at the upper thoracic region, and is fastened there by straps; from this the splints (short arm of the lever) descend to the seat of the disease, where they are supplied with appropriate pads (Fig. 103 a); while the long arm of the lever reaches to the sacrum, where it is united to the pelvic belt (Fig. 103 b). When (as in Fig. 103 c) the contrivance is fastened to the body, it represents a lever apparatus which stretches the vertebral column and fixes the spine, that is to say, it fulfils the indications. At *R* a belt is applied, which serves for the correction of any co-existing lateral deviation.

In many instances it is advisable, in order to permit a certain amount of muscular activity while the extension action is

at work, to employ special apparatus for locomotion in which the patient is partially suspended, and in this connection the various wheel crutches, etc., should be enumerated (Fig. 104). The patient may also exercise when suspended from an iron spring arm similar to that represented in Fig. 18.

For the later stages of kyphosis, when there is no further tendency to collapse of the affected portions of the spine, simple retention apparatus will suffice; for instance, corsets with accurately fitting pelvic belt and taking purchase on the iliac crests, lateral splints with axillary crutches, and slightly elastic posterior splints, with soft pads, if necessary, on both sides of the spinous processes. In still other apparatus[32] a posterior splint divides at the gibbus like a fork, and extends on each side of it. This splint is connected with the pelvic belt, and an elastic pad is placed over the prominent spinous processes, protecting them from injurious pressure and, in a measure, fixing them. Lateral splints are connected with the posterior.

Fig. 104.—Meigs' Spinal Aparatus (resembling Darrach's Wheel-crutch.)

In the acute stages of the disease, absolute rest, extension by various means (suspensory belt, etc.), and for affections of the cervical vertebræ Volkmann's extension by weights in particular are absolute indications. In the later stages, portable apparatus of varied construction, especially corsets of felt, plaster, etc., and the more complicated machines (Taylor's, Stillman's, etc.) must be resorted to, because otherwise the patients would be debarred from the important factor of exercise in the open air. Even when all symptoms seem to indicate complete recovery from the morbid process, it is advisable to have the patient wear for some time appropriate supporting apparatus, which takes pressure from the spine.

The gravitation abscesses, which are so frequently sequelæ of caries of the vertebræ, call for special consideration.

When we remember that Stromeyer declared, and with

truth for his day, that the opening of cold abscesses was not allowable because it was an operation which was nearly always followed by death or prolonged invalidism; and that nowadays, under antiseptic precautions, we not only open grave congestive abscesses, but make a wide incision, drain, etc., the change in opinion effected by the introduction of the antiseptic system is most striking. In all cases where we can guarantee efficient antiseptic after-treatment, early incision of these abscesses (as soon as they become accessible to the knife) should be the stringent rule of practice. Such is the view held by Leser,[33] of Volkmann's clinic, and by Koenig, Bardenheuer, Dollinger, and others.

Incision is followed by irrigation with warm aseptic fluid (borated salicylic-acid solution, weak sublimate solution). The pyogenic membrane is removed with the sharp curette as far as it can be detected. Usually the membrane can be easily wiped out with a wad of gauze or sponge held on a dressing forceps. Where possible, counter-incision and drainage near the diseased portion of the vertebra, suture of the wound, and antiseptic dressing should, in addition, be carefully resorted to.

At the first change of dressing, the drainage tube must be cleansed, so that permanent dressings, as a rule, are out of the question. Even where only minute fistulæ remain, strict antisepsis must be maintained.

In Volkmann's clinic, between 1873 and 1884, 58 cases of congestive abscesses were operated upon (among these 53 followed on spondylitis and the formation of a gibbus). There were no deaths from the operation; 23 permanently healed by first intention; 20 died subsequently of tuberculosis.

Psoas abscesses, which are frequently met with and can be opened even when still high in the iliac fossa, must be opened early and the purulent contents must be removed, thus guarding the patients against gravitation and spreading. This is in accordance with Dollinger's view.

The incision is made behind the anterior superior spine, and above and parallel to the crest of the ilium, and is then carried backward 2½ to 3¼ inches, the muscles being divided. The fingers are then inserted into the wound, the abscess is opened by a long incision, and the tubercular membrane is wiped out with a one to two per cent. chloride of zinc solution. After being cleansed, the counter-opening is made at the quad-

ratus lumborum and a drainage tube is inserted. Tincture of iodine diluted with water until it has merely a yellow color is also recommended for irrigation (Owen).

Retropharyngeal abscesses, in particular, must be opened early, since they may cause suffocation when they extend or rupture spontaneously. According to Hilton, deep cervical abscesses should be opened at once by incising the sterno-cleido-mastoid and making an exploratory opening through the deep fasciæ. If pus be obtained, the incision is extended. Still, even at the present time, many authorities pronounce against early operative interference (Noble Smith), and for those cases in which the necessary antisepsis cannot be assured, it should be remembered that we are also in possession of other less energetic measures, which may be carried out in dispensary practice, such as tapping the abscess with a trocar, followed by sublimate irrigation and iodoform injection. This method is performed by Schede and others.

The treatment by iodoform injections, according to the statements made by Fränkel,[34] Andrassy,[35] Verneuil,[36] and others, is a very simple, harmless, and effective procedure which is of the greatest value, especially in cases where the abscesses are very deep, if not almost or quite inaccessible. P. Bruns, for instance, had twenty permanent recoveries among twenty-two cases.

The aspirator needle, attached to the syringe, is thrust into the abscess, and the contents are withdrawn as completely as possible; then, through the same canula, we inject the iodoform solution (10 : 90 of glycerin, or 10 : 50 of water and 50 of glycerine) or a five per cent solution of iodoform in ether (Verneuil). As a rule, the amount of fluid injected should be from one to two fluid ounces, at most three fluid ounces, according to the size of the abscess.

According to Andrassy, the abscess usually rapidly refills to its former volume, and the aspiration and injection must be repeated, if necessary, at intervals of two weeks; in general, two to four injections are required. In the sixteen cases observed in the clinic until recovery was complete, the time occupied varied between two weeks and two and a half months —an average of four to five weeks (Andrassy), according to Fränkel six to eight weeks.

Skoliosis.

Under the terms skoliosis (from σκολιόω, to bend, to curve), lateral curvature of the spine (French, déviation latérale de la taille; German, seitliche Rückgratsverkrümmung; Italian, Scoliosi) we understand any permanent lateral deviation of the spinal column or a part of it from the normal physiological direction.

In a more restricted sense, the term skoliosis is applied only to the abnormal lateral curvatures caused by mechanical influences, exclusive of true morbid processes (Drachmann). The curvature seldom implicates the entire spine, total skoliosis; usually one portion of the spinal column is chiefly affected, partial skoliosis; and hence we speak of right dorsal skoliosis, left lumbar skoliosis, etc., according to the direction of the convexity of the curvature.

The curvature of a certain segment, however, never persists alone; owing to efforts at maintaining the equilibrium the original primary curvature soon becomes associated with secondary counter-curvatures (compensating curvatures); the simple skoliosis becomes compound.

Although statements such as those made by Werner (who estimated that there were 65,000 skoliotic persons in Prussia) have but a relative value, there is no doubt that skoliosis is the most frequent of all orthopedic affections. Berend found, among 3,000 orthopedic patients, 900 with skoliosis; Langgaard, among 1,000, 700; and Schilling, among 1,000, 600 with skoliosis. Drachmann, on examining 28,125 pupils, found 1.3 per cent skoliotic, 0.8 per cent boys, 0.2 per cent girls. Most observers agree that the majority of cases (9.335 per cent, Drachmann) occur in girls (10 : 1, Eulenburg; 577 : 144, Kölliker). The skoliosis of later growth (Vogt), which occurs almost exclusively among girls, is certainly traceable to definite causes, though it is possible that the proportion is rather apparent than real, and is due to the fact that the development of girls is watched with greater care and that they are, therefore, brought earlier to the physician. Even if the absolute frequency in girls is perhaps no more than double that in boys, still the physician is consulted about a much larger proportion in girls.

Roth found, among 200 cases, 183 females; Wildberger,

among 120 cases, 101; Lonsdale, among 170 cases, 149; Ketsch,[37] among 229, 189; Berend, among 896, 773, etc.

It is further of interest to note that counting the aggravated forms of skoliosis alone the number of males is in excess.

As to age, skoliosis occurs even during the first years of life, and then is usually of a rachitic nature. The great majority of cases (56.4 per cent, Eulenburg) develop between the seventh and tenth or fourteenth year, that is to say, at the time when the patients begin to go to school and are subjected to the associated injurious effects. In the female, the early establishment of puberty would seem to have an influence on the greater frequency of skoliosis.

Ketsch reports, from an analysis of the material of the New York Orthopedic Dispensary, that the number of cases of skoliosis between the first and twelfth year formed 52 per cent; from the twelfth to the eighteenth year, 14 per cent; of later development, only 3½ per cent.

FIG. 105.—Rachitic Skoliosis in a Boy of Four Years.

In general, it cannot be asserted that, aside from rachitis, an essential part is played by the diathesis in the production of skoliosis. Delicate, tall, and weakly children are most frequently attacked. In these respects, the better classes furnish the greater number of cases, while in the children of the poor bad hygienic conditions are to be blamed.

Skoliosis seems to be a consequence of civilization, and, according to several authorities, hardly ever occurs in savage races. Children with flat backs, it is claimed, furnish the greatest proportion of the graver forms of skoliosis.

As regards the tendency to skoliosis of the several portions of the spine, there is no doubt that dorsal skoliosis with the convexity of the curvature to the right (the ordinary habitual skoliosis) is the most frequent (Kölliker[38]). Drachmann states the proportion 42.3 per cent, Eulenburg 92.7 per cent, Adams 84 per cent, Heine 81 per cent. Still more recent investigatons (Drachmann, Lorenz) show that primary left-sided lumbar skoliosis is much more frequent than had been supposed; thus, Lorenz found among 163 cases, 62 left lumbar skolioses, 64 right convex dorsal skolioses; Klopsch[39] noted the same

fact, determining left convex lumbar skolioses in 71 cases out of 121 instances of skoliosis (all girls). Meyer, Schmidt, and others have made similar observations.

As will appear hereafter, however, left convex skoliosis is rare in later childhood (21 per cent, Drachmann) and more frequent only in nurslings and infants. It usually appears as a left-sided deviation (*skoliosis simplex totalis*) of a rachitic nature.

Very rarely does skoliosis consist in a simple lateral bending; as a rule the condition is associated with a rotation, a tortion (rotatory lateral curvature) rendering the deformity

Fig. 106.—Slight Habitual Skoliosis in a Girl of Thirteen Years.

Fig. 106a.—Fixed Skoliosis in a Girl of Eighteen Years.

of the spine serpentine (see Figs. 111, 113). This compound deviation is necessarily conjoined with a displacement of the ribs and hence there results deformity of the thorax (see below) when the dorsal vertebræ are affected. We must, then, define skoliosis as a distortion of the trunk in which an abduction and rotation of the spinal column is associated with deformity of the thorax (Vogt).

According to the mode of origin we distinguish congenital, habitual, static, professional, pathological (inflammatory, cicatricial, empyematic), traumatic skolioses.

According to Eulenburg, an hereditary factor may be de-

monstrated in 25 per cent of 1000 cases of skoliosis, and P. Vogt also finds that heredity can be shown to be a cause in more than one-half of all the higher grades; in such cases there is a transmission of a peculiar form of development of the spinal column which manifests itself only at a certain period of evolution.

Congenital skolioses are, however, extremely rare, and they are due either to a *vitium primæ formationis* or they are the consequence of other deformity. Busch, among others, has described an interesting instance.[40] Rachitis and other processes associated with abnormal softness of the bones (osteomalacia) rarely of themselves give rise to skoliosis; as a rule to the abnormal quality of the bones is superadded, as a predisposing factor, the effect of weight. The most frequent form of skoliosis, the so-called habit-skoliosis, must be considered as a deformity due to the effects of weight, and here we are dealing with a lessened sustaining capacity of the spinal column occurring at the time of the second dentition and associated with the increase in growth of the skeleton which occurs at this time. These are the predisposing causes, and unequal weight on the growing parts of the skeleton is the exciting cause. So-called static skoliosis arises from unequal length or functionating power of the lower extremities, which leads to obliquity of the pelvis and to primary deviation of the lumbar vertebræ.

Staffel, for instance, found the static cause present in 76 out of 230 cases.

The pathological skolioses, on the other hand, are exceptional. Skoliosis is here due to osseous or articular disease of the vertebræ, *i.e.*, primary osteogenetic and arthrogenetic skoliosis, or to disease of the surrounding soft parts (myogenic, dermatogenic, etc.). The inflammatory skolioses are usually combined with kyphotic curvature and occur particularly in the cervical region of the spine as the so-called *caput obstipum osseum*, and also largely as arthritis deformans of the lumbar region of the spine, etc. Cicatricial skolioses may arise from extensive burns, phlegmons, defects of the ribs due to caries, necrosis, etc. Empyematic skoliosis is more frequent, and it occurs in consequence of contraction and the formation of false membranes with defective expansibility of the diseased side following on empyema; usually the concavity is turned to the affected side.

It is doubtful whether a purely muscular disease may cause skoliosis, as, for example, a rheumatic skoliosis due to inflammation of muscles (as is claimed by Eulenburg and others); cases have been recorded, however, where skoliosis has followed on a neuritic process, such as sciatica (Albert, Nicoladoni[41]). The explanation offered is that in sciatica the patient instinctively endeavors to obtain more space for the swollen nerve fibres which are inclosed in the lumbar segment of the spine, and therefore bends to the opposite side.

Only after eliminating all other possible causes may we assume that a simple disturbance of innervation is at the base of a skoliosis.

Trauma rarely results in skoliosis, since fractures of the vertebræ are more likely to cause curvature in the sagittal plane. Non-reduced luxations of the cervical vertebræ might possibly, however, lead to permanent lateral curvature of the spine.

By far the great majority of skolioses are to be considered as deformities due to weight, and since the patients permanently assume an oblique position, the vertebræ under the unequal weight acquire an asymmetrical form and thus habitual skoliosis arises. Besides the faulty position maintained during writing, which is a chief source of the deformity, a number of occupations which require an oblique position (violin playing, one-sided bearing of burdens) may cause skoliosis, and indeed we not infrequently see in some occupations what may be termed professional skolioses.

If the first tendency to skoliosis has resulted from the habitual assumption of an oblique position, then its increase toward a curvature will naturally ensue from the unequal pressure; for increase in growth of the portion of the young bone least exposed to pressure, and retarded growth of the portion most exposed, while this bone is still plastic, leads both to the wedge-shaped malformation of the vertebræ and the torsion of the skoliotic segment. If now we consider first the anatomical alterations of the skoliotic spine, by inspecting, say, a pronounced (habitual) skoliosis with right-convex dorsal, left-convex lumbar curvature, and left-convex counter-curvature in the cervical segment, it is readily apparent that the curvatures are situated, not in the sagittal plane, but in diagonal planes (Fig. 113), and even on viewing them from above

they are not seated in a frontal plane. The curvature is rather serpentine, spiral, and there is, aside from the lateral curvatures, a twisting of the median sagittal plane of the vertebræ around a vertical axis which is termed rotation or torsion and which strikes the eye on inspecting any skoliotic spine from in front, by noting the most anterior points of the several vertebræ (see Fig. 113).

A perfectly accurate conception of the anatomical alterations will be possible only when all the stages of the skoliotic process have been studied. The alterations of the initial stages would certainly be of the greatest interest. In this stage we must surmise that there has existed unequal ossification, for cases are on record where ossification had advanced

Fig. 107.—Skoliotic Dorsal Vertebra, Front View.

Fig. 108.—Frontal Section through two Skoliotic Vertebræ.

much farther on the convex side of the skoliotic curve (Nicoladoni).

The anatomical changes do not mainly affect the ligaments as was formerly believed, but the bony framework; and the several vertebræ not only undergo change in form by the lateral curvature, which may be briefly designated as atrophy of the concave half of the bone with resulting wedge shape of the skoliotic vertebra, but also in torsion (torsional changes) which causes the chief deformity, the costal projection.

If we compare one of the skoliotic dorsal vertebræ with a normal one, we notice, on inspection from in front (Fig. 107), that the former is wedge-shaped with the base toward the convexity (and this wedge shape is most pronounced on the eminences of the curvature and may be so great that several vertebræ are actually joined in one curve, and may become

fused into one by an osseous proliferation due to periosteal irritation). (Fig. 110.)

This wedge-shaped deformity affects not only the bodies of the vertebræ, but also the roots of the arches, the articular surfaces, etc. (Fig. 107) (Lorenz).

The root of the arch on the concave is shorter than that on the convex side; at times the former appears as if retracted into the upper surface of the body of the vertebra, often it is reduced to a very thin translucent piece of bone. The articu-

Fig. 109.—Skoliotic Dorsal Vertebra seen from in Front.

Fig. 110.—Part of the Dorsal Portion of a Skoliotic Spine.

lar surface of the arch on the concave side is also much reduced in height; the upper one in particular is often changed into a low translucent flake of bone. The articular surface, by including the neighboring portion of bone, whose periosteum is transformed into a kind of fibro-cartilage, is irregularly widened; while on the side of the convexity, where the articular surfaces are partly lifted from each other, they become gradually smaller by the disappearance of the cartilage.

The vertebral canal is ovoid, the larger end being directed to the convexity, the smaller to the concavity; this results

from the altered position of the roots of the arches which
not diverge uniformly, but have an asymmetrical directi

FIG. 111.—Lumbar Skoliosis (rotation), Front View.

FIG. 112.—Lumbar Skoliosis (rotation), Rear View.

The root of the arch on the convex side approaches the sag
tal, that on the concave side the frontal direction, and t
ideal union of the roots of the arches is not sagittal in front

FIG. 113.

FIG. 114.

the vertebræ as in the normal condition, but on the side of t
convexity. The vertebral body itself is even asymmetric
the concave half presenting a more frontal, the convex half

more sagittal direction. On viewing a macerated skoliotic spine from in front, we observe a peculiar oblique direction of the bony fibres instead of a vertical one; this is especially noticeable in the single vertebra (Dittel, Fischer, and others), and becomes more conspicuous the higher the grade of the deformity. The internal vertebral structure is also similarly altered, the oblique course of the bony trabeculæ producing a shortening of the vertebra; hence the torsional changes should be looked upon mainly as a torsion of the bones (Volkmann, Lorenz) and not as a rotation in the articulations.

Similarly, the transverse process of the convex side has

Fig. 115.—Portion of a Skoliotic Spine Seen from Behind.

Fig. 116.—Skoliotic Spine and Protruding Ribs, Rear View (Specimen in the Munich Pathological Institute).

usually a more sagittal position and is directed more backward; that of the concave side is more frontal and the angle formed by the transverse and spinous processes becomes more acute on the convex side, the *sulcus paraspinosus* being narrower, etc. (Fig. 117).

The spinous processes are displaced to the concave side with reference to their insertion, whilst the direction of the points of the dorsal spinous processes form, so to speak, an excrescence toward the convexity. The row of the extremities of the spinous processes does not correspond with the intensity of the curvature, being sometimes in a straight line (Fig. 112) notwithstanding aggravated skoliosis.

As regards the explanation of the appearances of torsion, it is no longer possible to accept the view of Nicoladoni (who looked upon them as an optical effect) or that of Hencke, viz., rotation in the articulations. The same may be said of the different attempts at explanation by Roser, Meyer, Maigaigne, Dick, Eulenburg, Drachmann, Schenck, etc., which will be found in Lorenz's work. Lorenz finds in the presence of the epiphyses of the roots of the arches the tendency to torsion of the growing vertebra, in the same way as the epiphyses of the bodies of the vertebræ favor the wedge-shaped deformity, and he lays stress on the sudden bend of the basal epiphyseal joint of the roots of the arches toward the middle line or the concave side; for here, as the point of least resistance, the root of

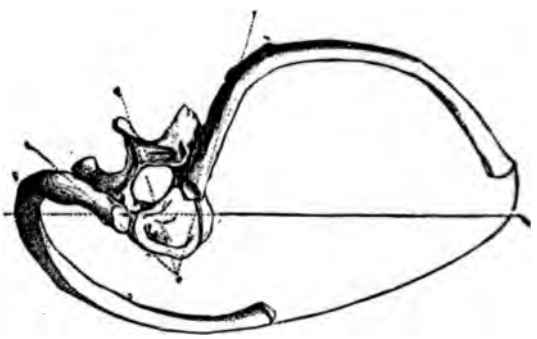


FIG. 117.—Skoliotic Thoracic Hoop. (After Lorenz.)

the arch with the adjoining thoracic hoop, as it were, remains behind the body of the vertebra which is crowded out of the middle line as the result of pressure.

Of the greatest importance with reference to the deformity are the anatomical alterations of the ribs which are closely united with the vertebræ and which cause the marked change in the shape of the thorax. These alterations may also be divided into alterations in position and into alterations of torsion (changes in shape), the latter being much more important. Since the rib, as far as its angle, is to a certain extent dependent on the arch of the vertebra, there results a more or less sagittal direction of the root of the rib on the side of the convexity; hence the greatly flexed costal angles cause a serious deformity, (the so-called posterior costal eminences), while the ribs of the concave side, being directed more to the front,

show a diminished curvature and this explains the flattened condition of the skoliotic thorax.

These costal curvatures at the posterior part must correspond to diametrically opposite curvatures at the anterior part of the ribs, and the places where the more strongly curved portions of the ribs join the more extended portions are termed, in turn, the anterior costal eminences (at *k*, Fig. 117). As to the changes in position of the ribs in skoliotics, in case of dorsal skoliosis all the ribs are depressed on the side of the convexity (Fig. 116)—a fact to be explained probably by the resistance of the muscles of the trunk to their elevation (Lorenz). At the concave side, the ribs of the lower border of the curvature are moderately depressed; superiorly this depression becomes less, the ribs grow horizontal and finally are slightly elevated. The ribs of the convexity are divergent, while those on the concave side are approximated, usually atrophic, and where the skoliosis is great they may articulate with each other or be united by synostoses.

In skoliotics, therefore, the thorax is oblique, and in right-convex curvature the thorax extends in the right, in left-convex curvature in the left diagonal diameter; the convex half of the thorax is diminished in all dimensions, the capacity of the concave side is lessened only in height, but is increased in all the other diameters. In a horizontal section the skoliotic thorax represents an ellipsoid whose greater axis is formed, in right-convex curvature, by the right, the lesser by the left diagonal diameter (Fig. 117).

Aside from the rachitic form, the pelvis in case of habitual skoliosis is not in general much deformed. Adams says in this connection: "Obliquity of the pelvis is supposed to exist much more frequently in cases of lateral curvature than it really does." In the severer degrees of skoliosis, especially that of the lumbar segment, the pelvis is somewhat oblique. The deformity of the sacrum is above all the cause of asymmetry of the pelvis. In left-convex lumbar and in right-convex dorsal skoliosis the left diagonal diameter of the pelvic inlet appears elongated, and the right shortened; hence the obliquity of the pelvis is opposed to that of the thorax.

The changes in the ligaments are only the consequences of the alteration in the shape of the affected parts of the skeleton, and those of the muscles (especially of the long dorsal

muscles) are not very marked. In the early stages of the skoliosis there are no changes in the muscles; in more chronic cases, the muscles on the side of the convexity are relaxed, pale, and fatty degenerated, while those on the concave side are altered to a less degree. The relations of the long dorsal muscles to the spinous processes are altered, the distance between them being increased on the concave side, and lessened on the opposite side; in the higher grades of skoliosis the longitudinal muscles may become subluxated over the spinous processes on the concave side. The broad dorsal muscles also adapt themselves to the deformity of the thorax; thus the rhomboids, passing over a costal eminence on the convex side, are usually thinned and atrophic; on the concave side they are shortened and thickened.

The numerous theories in regard to skoliosis can scarcely be harmonized with these anatomical findings, and we shall here consider only very briefly the various attempts at explanation. As Copeland aptly says these views furnish material for a keen satire on the medical art.

Up to the beginning of the present century, skoliosis was looked upon as an arthrogenous affection, and the ligaments in particular were thought to be at fault. Delpech, Guérin, Eulenburg, and others sought the causal factor in disturbed muscular antagonism (the myogenous view). Some assumed a paralysis of the dorsal muscles on the convex side, others a contraction on the concave side of the curvature, and the latter view led to the performance of myomotomies in skoliosis, which operation was shown by Malgaigne to be based on false premises. A weak constitution was considered to be the predisposing cause of the habitual oblique position. This led to passive dilatation and weakening of the dorsal extensors on the convex side, the exciting cause of skoliosis. Although this myogenous theory has been sufficiently refuted by Werner, it is still held by some. Neither the anatomical nor the clinical facts are supported by Stromeyer's respiratory theory which explains the skoliosis by a unilateral relatively stronger action of the right serratus—a view maintained by Sayre, for instance, for primary dorsal skoliosis. The views maintained by Malgaigne and Adams of a primary relaxation of the ligamentary apparatus, or Werner's gratuitous view of the primary disturbance of the will, also offer insufficient explanation. A

mere historical interest attaches to Hueter's theory of pressure by growth of the ribs, the fallacy of which was clearly shown by Dornblüh and Lorenz, and is proved, in addition, by the occurrence of primary deviations in other segments of the spine.

Lorinser defended mainly the osteogenous explanation, *i.e.*, he found the tendency to a skoliosis in an insidious inflammation of the bone, an inflammatory softening process, the patient instinctively assuming the position in which he escaped as much as possible the effect of pressure on the softened part. Lorinser sees in skoliosis a morbid process in nowise differing from kyphosis, but considers both expressions of the same disease, only varying in degree. The cases, however, are rare in which we find anatomical alterations corresponding to this theory (as in a case recently observed by me).

Von Lesser [42] produced skoliotic curvature experimentally in animals by unilateral division of the phrenic nerve and believed that unequal functional development of the two halves of the diaphragm also played a part in human skoliosis.

Another theory sees in skoliosis only a pathological increase of the lateral curvature which, according to Sabbatier, Bouvier, and others, is physiological. It is not certain, however (Adams, Lorenz), that skoliosis is physiological as is claimed, about the seventh year, and which is thought to be due to the pulsations of the aorta (Sabbatier), to the greater weight of the organs on the right side (Desruelles, Struthers), to habitual right-handedness (Busch), and generally to an increased growth of the right side of the body. Schildbach and others defended the view of a primary anomaly of growth. The theory of pressure, which is applicable to the majority of skolioses (Roser, Volkmann, etc.), *i.e.*, the conception of skoliosis as a gradual transformation of the previously well-formed spine under mechanical influences has at present the greatest number of adherents.

It is evident that in most occupations and even in ordinary relaxed attitudes, unequal pressure is present, and that, if this be continous, especially about the seventh year at the time of the second dentition, which is associated with increased growth of bone, development will be uneven and the deformity will become greater. Attendance at school at this critical time, and especially faulty position during writing, which is largely

due to badly constructed seats, are chiefly to blame for beginning skoliosis.

In the position which the fatigued child usually assumes in writing, the right shoulder is higher and projects forward, the right forearm rests on the table, while only the left hand or a few fingers, touch the oblique book or the table,[43] especially when the desk top is too far from the seat; this causes a right convex dorsal curvature of the spine. According to others, the left curvature of the spine (Fig. 118), especially that in the lumbar region, is more frequent, but its frequency is underestimated owing to the symptoms being less conspicuous. Schenck has determined with a special apparatus the position in writing of 200 children, and found that in 160 the trunk was displaced to the left on the pelvis, the weight of the body resting on the left elbow and arm, thus producing a left-convex total skoliosis; 34 pupils displaced the trunk to the right, but turned to the left so as to relieve the pressure on the right forearm which was used in writing, and they exhibited an habitual dorsal skoliosis with very pronounced right dorsal flexion; only 6 showed no lateral displacement of the trunk during writing; in all, excepting 38, the pelvis was not parallel but oblique to the edge of the desk.

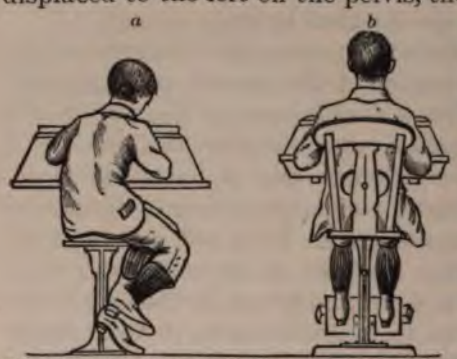


FIG. 118.—*a*, Faulty; *b*, Correct position. (After Roth.)

In addition to faulty position in writing, skoliosis is favored by all acts and occupations causing obliquity of the pelvis and sinistro-flexion of the trunk. Here unequal pressure and the resulting dissimilarity in growth cause skoliosis.

As for the symptoms of skoliosis, the onset cannot be determined clinically. The affection must reach a certain degree of development before it gives any external indications. Rarely it is the curvature in the line of the spinous processes which is first observed, more frequently the greater height of one shoulder or hip; often, in beginning skoliosis, it is possible to recognize only a slight displacement of the trunk on the pelvis, which is always in the direction of the primary curva-

ture (in the right primary dorsal curvature to the right). As a result of this displacement, the lateral borders of the body become asymmetrical; in right displacement the right waist line and the right crest of the hip disappear, while the left outline has a concave sweep, the left hip being prominent, the left waist line somewhat deepened, and *vice versa*. The arm, on the side of the displacement, hangs down; on the opposite side it is opposed to the crest of the ilium, where it forms a triangle with the waist line (Lorenz) which becomes unequal in bilateral skoliosis (see Fig. 120). According as there exists a primary lateral curvature in the lumbar or dorsal spine, we find the position of the hip or shoulder altered as the expression of the deviation of the vertebral column, and according

Fig. 119.—Beginning Skoliosis (right side), Girl aged Four.

Fig. 120.—Primary Left-convex Lumbar Skoliosis. (After Lorenz.)

to the appearances we may distinguish between a primary lumbar and a primary dorsal skoliosis.

In primary left-convex lumbar skoliosis, the relatively frequent occurrence of which, as a primary deviation, has been repeatedly referred to, the left angle of the waist appears flattened or completely obliterated in the higher degrees, so that the left arm is in contact with the lateral surface of the trunk nearly throughout. The right angle of the waist, on the contrary, is more acute, and, in well-nourished persons, a transverse fold extends toward the middle line, while the distance of the arm from the waist line is increased. There results, hence, a diminution or disappearance of the left, an increase in the right triangular outline of the waist, that is to say, a deepening of the right waist line. The left waist line, and the

crest of the left hip disappear; on the side of the concavity they become more prominent, and, owing to the rotation of the lumbar spine, the left lumbar region becomes fuller. A prominence is visible in the left lumbar region along the middle line which is also noticeable on palpation and especially when the patient bends forward. The longitudinal swelling of the erector trunci appears much flatter than on the right, because the transverse processes deviate forward. As the affection increases, changes of position (counter-curvatures) also occur in the dorsal vertebræ. Primary right-convex lumbar skoliosis, a very exceptional condition, causes similar changes, although, of course, on the opposite side.

Primary right-convex dorsal skoliosis (next to the left-convex lumbar skoliosis the most frequent and important variety), in its first stages, while the spinous processes may still be entirely in the middle line, presents a slightly increased curvature of the right costal angle which becomes more conspicuous on inspection from above. Soon the changes in the position of the scapulæ become marked, *i.e.*, the right scapula projects backward, is somewhat higher, and its outlines are sharper (resting as it does on a higher base, that is, on the more strongly backward-curved ribs); while the less prominent left scapula, slightly twisted, approaches with its angle the sagittal axis (the left upper extremity sinking down on the flat ribs), and a fold of the skin extends from the left scapular angle down and outward to the waist line. Essential alteration of the lateral contours is not perceptible. Shortly, the secondary lumbar curvature is superadded and at the same time the lateral outlines become more and more asymmetrical, the right waist line becomes deepened, the right hip more prominent, while the crest of the left hip is obliterated, the left triangle of the waist is elongated and nearly semilunar. This latter circumstance presents an essential differential point from primary left convex lumbar curvature (Lorenz). The concavity of outline on the left side becomes

Fig. 121. — Primary Right-convex Dorsal Skoliosis. (After Lorenz.)

still more pronounced when the entire trunk is displaced on the pelvis to the right. Then the angle on the right at the waist opens outward, the right arm hangs down straight and the projection of the right hip is absent (Fig. 122).

As soon as we can recognize a deviation of the spinous processes, the diameter of the half of the body on the side of the convexity appears shorter, and this is also the case in lumbar skoliosis, while in dorsal curvature the conditions are obscured because the greater distance of the right scapula from the spinous processes simulates a widening of the right half of the trunk.

In case a compensatory left-convex cervical curvature is superadded, then we notice a characteristic alteration in the shoulder line across the neck. This normally forms a gentle double curvature. It becomes flattened on the left, the left side of the neck is shorter, and the rounding of the left shoulder is less prominent laterally; while on the right side the neck is longer, the rounding of the shoulder more prominent, and the line across the shoulders is more curved.

In comparison with this form of curvature of the fully developed habitual skoliosis (*skoliosis duplex adolescentium*), the remaining forms are of but little practical interest on account of their rarity, and their symptoms will be discussed in connection with rachitic and static skoliosis.

The onset of skoliosis differs in so far as in certain instances left-convex lumbar skoliosis appears first, in others right-convex dorsal skoliosis. Only exceptionally does the deformity begin at the outset with several curvatures.

Ordinary habitual skoliosis, as a rule, has an insidious course, it develops slowly and increases gradually; but at times, especially in girls of rapid growth, the development and increase of the affection are exceedingly short, so that in the course of a few months high grades of deformity may be produced; usually the affection progresses the more quickly the younger the patient.

In general, three stages may be distinguished:

In skoliosis of the first degree we deal, as it were, with an habitual skoliotic attitude; marked costal projection is not yet present; by vertical suspension, horizontal decubitus, or slight manual pressure the curvature of the spine can be readily made to disappear.

In skoliosis of the second degree the deformity can no longer be entirely removed by active motions, suspension, etc.; the torsional changes are marked, and the differences in level of the posterior surface of the thorax disappear only in part even on suspension, although the curvature of the spine may still become quite or nearly obliterated. As a rule, compensatory counter-curvatures have already developed.

FIG. 122.—Pronounced Grave Habitual Skoliosis.

In skoliosis of the third degree, there is complete or almost total unalterability of the curvature, whether on manual efforts or on vertical suspension. The spine has become rigid by unilateral atrophy and ankylosis.

Skoliosis may become stationary in any stage and does not always reach the highest grades.

Early diagnosis of commencing skoliosis is of the greatest importance, since the first stages chiefly offer hope of cure from treatment. The indifference with which the anxious mother is quieted by the physician consulted for the "high shoulder" or the "oblique attitude" of a child, with the statement that this will be "outgrown" and spontaneously disappear, without even making a careful examination, cannot be too strongly condemned and must be taken to indicate a lack of conscientiousness when we bear in mind how frequently skoliosis and its consequences destroy the happiness of the afflicted individual.

Eulenburg justly criticises the indifference of many family physicians toward beginning skoliosis, "for while in other diseases not pertaining to their special sphere, as of the eye,

ear, etc., they usually refer their patients to a specialist, in cases of spinal curvature they unnecessarily assume a responsibility which the daily sight of numerous unfortunate victims should have rendered distasteful to them."

The factors to be taken into consideration, therefore, in the examination of a beginning skoliosis must here be discussed more in detail. By inspection we must first notice the attitude of the patient (whether there is displacement of the trunk on the pelvis, whether one shoulder is higher than the other, whether the waist is oblique, etc.); in addition, we must observe the excursions of the thorax during respiration. The fact must be emphasized that the patient must be stripped down to the trochanters. The clothing should be tied around the trochanters, otherwise the patient, in order to prevent their fall, moves constantly and does not remain quiet and erect. The hair should be tied over the head, the arms should hang free at the sides, the toes should be equally directed outward. After the patient has been inspected in his ordinary position he is told to assume a firm military attitude. Under good illumination, the light by preference falling from behind on the patient so that no disturbing shadows are thrown, the back is inspected from behind and from varying distances, the relations between pelvis and trunk, the position of the shoulders, the lateral outlines, the waist lines, the relations of the pendent arms to the trunk, the condition of the triangle of the waist, etc., being noted. On inspection from in front, the relations of the neck, navel and symphysis should be noted, as to whether they are in one plane, whether one region of the costal cartilages projects more strongly or one mamma is more prominent, whether the sternum is in the middle line, etc. The spinous processes are next stroked by the finger tips, a red line being produced marking the course of these processes and making a curvature or deviation from the normal evident; the condition of the paraspinal sulcus is noted, as to whether it is filled up on one or the other side, etc., and in high grades of torsion care must be had not to mistake the lateral vertebral processes, which are well marked on the convex side, for the spinous processes.

In beginning dorsal skoliosis it is advisable to cause the patient to lay his hands on the opposite shoulders, crossing the arms, or else the patient with extended knee joints and

raised arms should be directed to bend forward, whereby the region of the costal angles can be better inspected and the fact of torsion becomes more evident.

The possibility of overcoming any alteration of form is next tested by attempting to restore to its normal position the projecting costal eminence by means of gradual pressure. Next it is noticed whether static alterations (*e.g.*, the placing of a book under a shortened leg, etc.) will cause disappearance of an existing curvature. The condition of the patient having been tested both under active changes of position and by passive measures (diagonal manual pressure), if the curved segment is found to be even slightly movable, the behavior during vertical suspension is tested to determine whether compensation can be effected or not, and at the same time we may endeavor by means of manual pressure to ascertain if the thorax can be sprung back into the normal position, as is usually the case in children with slender bony framework.

Sometimes it is essential to examine also in the horizontal abdominal position. The length of the legs must always be carefully compared.

The prognosis of skoliosis in general is unfavorable, and only when the case comes early under treatment may a good result be attained and the progress of the disease be arrested. The prognosis in primary lumbar skoliosis is, in particular, more favorable. Correction of the deformity here presents less difficulties. By means of Lorenz's belt dressing (see below) with elevation of the corresponding half of the pelvis by the interposition of extra soles on the shoe, cure may be effected in a relatively short time, that is to say, in a few months. The prognosis of primary dorsal skoliosis is worse, but in general more favorable when the changes in shape of the ribs are not pronounced. Where the disease begins without notable lateral displacement of the thorax, it is usually first noticed through the projection of one shoulder, and in most cases we must rest content with preventing the further advance of the curvature. We must beware of assuming too early that the skoliosis has become stationary, and we must rather consider it the rule that a beginning deviation progresses into the higher grades. The third stage is absolutely incurable.

Skoliosis is a permanent misfortune, not alone on account

of the deformity, but also because of the associated embarrassment of the respiratory and circulatory organs. For although the general health, even if the patient is skoliotic in a high degree, is often very little affected and the thoracic organs adapt themselves nicely to the altered space, still, in the graver cases, there is a certain insufficiency of respiration, there is dyspnœa on moderately active movements, which becomes quite marked on prolonged muscular exertion during walking, singing, etc. There is also a tendency to chronic catarrhs, etc. Digestive disturbances, congestions, cyanosis in consequence of defective emptying of the cardiac cavities, a certain tendency to hemorrhages, etc., these should be considered as direct sequelæ of grave skoliosis. According to Bouvier, heart lesions and apoplexy are the most frequent causes of death in skoliotics.

Severe skoliosis may further be accompanied by very painful symptoms. Aggravated neuralgia may be caused by pressure through the depressed ribs on the intercostal nerves.

Positive proofs are wanting in regard to the truth of the belief that skoliotics are short lived. The risks from skoliotic pelvic anomalies in women have also been greatly overestimated; only when the disease is of high grade, especially if of rachitic origin, does it interfere with gestation. This is certainly not the case in the slighter grades of the deformity.

In order to enable us to observe the course of the affection and the influence of treatment, we must resort to scientific methods of measurement in skoliosis. Since the taking of plaster casts at intervals for obtaining a picture of the deformity (Heine) is rather cumbersome, and the outlining of the trunk by means of the camera obscura (Schildbach) reproduces only a small portion of the alterations, it was but natural that the photographic reproduction of the patients, as practised by Berend and Wildberger, should find many imitators, particularly since stereoscopic views yield such excellent reproductions of the curvature that they were specially recommended by Lorenz.

In order to obtain actual measurements of the skoliotic curvature, it was formerly the custom to notice mainly the lateral deviation from the vertical; to take the diameter with the callipers or the outlines with a lead band or kyrtometer so as to gain by this means, at definite intervals, a picture of the progress of the affection, etc.

Only in recent times, however, have we had at our disposal exact scientific apparatus which will soon displace the methods of earlier date.

Bühring's[44] apparatus consists essentially of a glass plate 16 inches broad and 20 inches high, divided into half-inch squares, which is movable by means of a frame on a vertical scaffold on the sides of which is a device for fastening the arms. In the centre of the upper border of the frame is a plumb line, while below is a horizontal projection to which is fastened a diopter movable on a vertical rod. The apparatus with the diopter is placed toward the light with the patient behind it; his arms are fastened to the scaffold, and the outlines are drawn on the glass with a brush and paint; the plumb line is fastened at the level of the spinous process of the seventh cervical vertebra, and by means of the diopter the curvature of the spine and its deviation can be accurately marked. The apparatus, therefore, permits only the measurement or pictorial representation of the line of the spinous processes and of the lateral contours; it gives no picture of the torsion and no real image of the deviation of the vertebræ, and is hence of little practical interest for the measurement of skoliosis. The same may be said of Gramko's method.[45]

The apparatus which permits measurement in two or more planes is more suitable, for instance, that of Heather Bigg.

Schildbach's camera gives only the outlines and cannot reproduce the differences in level of the back.

For obtaining horizontal contours, a good apparatus is the thoracograph made on the system of the hatter's form by Walter Biondetti at the suggestion of Socin. About four to six thoracic outlines are drawn and designated by the corresponding spinous processes; these are cut out of strong paper for comparison with those taken later.

The apparatus of Murray[46] (Stockholm) is similar to Burkart's modification of the above.

The thoracograph of Schenk[47] permits the drawing of the horizontal outlines and of measurement at any desired point; the patient is placed in the centre of a massive ring, the pelvis and shoulders being fixed and the head resting against a pad. Around the ring is the plane for drawing; where this plane joins the ring is a vertical column divided into centimetres which bears the movable bent index pointing inward and

connected with the writing lever lying on the movable plate. While the drawing-plane is carried around the ring, the index, depressed by a rubber band, follows the outlines of the body horizontally and the writing lever marks on the slowly rotating writing plane the exact tracing of the motions of the index. It is possible by means of this apparatus to project any point of the body on the horizontal plane. Schenk usually makes one outline at the height of the spines, another at that of the acromia, measures the line of the spinous processes every five centimetres and projects the position of the several points on the drawing-plane, so that at the termination of the measurement the line of the spinous processes may be constructed in a sagittal and in a frontal direction.

For simple measurement of the lateral deviation Heineke's pendulum rod[48] is appropriate. After marking the spinous processes with a blue pencil, the belt with the triangular plate is laced around the pelvis, so that the point of the metal plate is exactly over the anus. Opposite to this, on the metal plate, a rubber cord is fastened and is stretched to the spinous process of the seventh cervical vertebra and thus the points where the sagittal plane and the line of spinous processes cross can be easily marked, and the deviations from the sagittal plane may be measured in centimetres. For measuring any lateral inclination of the spine as a whole, the pendulum rod is used, being hung to a stud projecting at a right angle from the belt plate. As the rod is divided into centimetres and reaches to the head, any deviation from the median line, for instance of the vertebra prominens, can be readily measured.

The skoliosometer of Mikulicz[49] permits the measurement of the height of the spinal column, its lateral deviation, torsion, the height and position of the shoulders. It consists essentially of a vertical and a horizontal narrow steel band, flexible so as to follow the lines of the body, and divided into millimetres. These bands are so joined by a brass piece that the horizontal rod can be moved both laterally and vertically. The longitudinal rod is fastened to a metal plate (which is joined to a pelvic belt by a corresponding pad) and it carries a horizontal goniometer from which may be read the position of the thin pointer which forms the end of the longitudinal band, the motion of which is around a vertical axis (indicating the torsion).

Since the apparatus is movable around a horizontal axis at the pad, the longitudinal rod can always be given the direction of the inclined spine. Height, lateral deviation, and position of the shoulder blades are measured by corresponding position of the transverse on the longitudinal rod. According to Mikulicz, measurements with this simple apparatus can be completed in from five to ten minutes.

Probably the most complete apparatus for measuring skoliosis, the only objection to which is its high price, and the application of which is simple and rapid (fifteen to twenty minutes for complete measurement) is that of Schulthess.[50] It permits measurement in three planes and gives a complete plastic representation of the trunk, and all the important bony points can be fixed in their mutual relations. It consists of a heavy cast-iron frame, the sides of which are joined at the back and bottom by iron rods, and which carries the devices for fixing the patient and making measurements or drawings. For fixation there are four adjustable pads: two to rest against the anterior superior spines (2 and 3), two broader ones for the hip or pelvis (4 and 5), which can be set parallel to the measuring plane. A board, 1, which can be set higher or lower on the four toothed rods of the side-pieces, permits the use of the apparatus for persons of different heights.

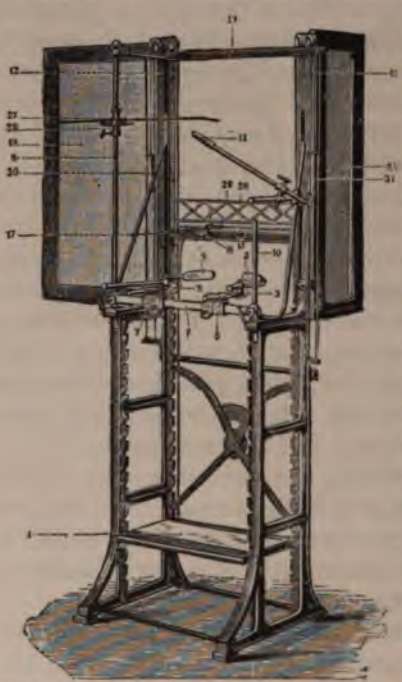


Fig. 123.—Schulthess' Apparatus for Measuring and Delineating Spinal Curvature.

The base of the measuring and drawing appliance is formed by two exactly parallel lateral slides, 12, 13, and their transverse connection, 14; between the former is a brass frame, 15, about twenty inches broad, which can be moved up and down,

being held in equilibrium by a counter-weight running over pulleys, so that a slight pressure of the hand suffices to raise or to lower it. On this frame, 15, is a small rider which travels to and fro, and in order to permit motion also in the third dimension (depth), the rider is perforated at a right angle to the direction of its motion, the perforation carrying a blunted steel pointer, 17, which can be greatly lengthened by the addition of a second pointer. Hence this pointer can follow the course of any line accessible to the measuring frame. The motions of the pointer are transmitted to the paper-covered glass plates, which are at right angles to each other, in the following manner:

1. From the rider, 16, a horizontal lever twenty inches long is extended laterally, 18, and it carries at its outer end a pencil which marks on the vertical plate, 19. This plate has the same direction as the measuring frame and forms the projection of the object to be measured on the measuring plane (Fig. 124).

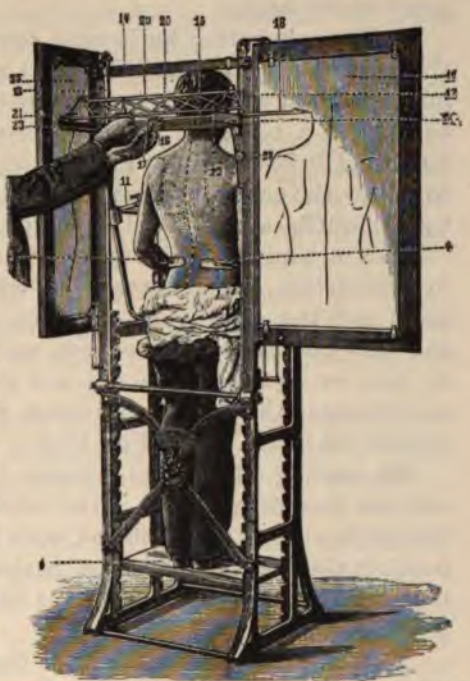


Fig. 124.—The Same Apparatus in Use; on the Right Plate is the Projected Frontal Picture; on the Left, the Posterior Sagittal Contour.

2. The posterior end of the pointer, 17, is so joined to a steel rod, 20, placed parallel to the brass frame by means of a forked eye, that it may be easily shifted from one end of the rod to the other. The steel rod with its two ends lies, by means of two rollers, 21 and 22, on the rail-like carriers which project backward from the brass frame, 23, 24, and it thus follows the slightest motions of the pointer connected with it, while it remains at rest during lateral movements of the rider, 16, or pointer, 17. To assure these movements, especially with ref-

erence to the parallelism of rod and measuring plane, its outer ends are united at the rollers by means of two levers to a right-angled lattice, 26, which in turn is made movable in the rails, 23, 24, by dowels at its two lower corners. At one end of the steel rod, 20, is a pencil which writes on the smaller vertical plate, 25, and furnishes the tracings of the kyphotic or lordotic deviation, and these tracings may be taken at any point of the back.

3. For delineating horizontal contours, there is applied to the posterior end of the pointer at a right angle to it, a writing lever, and when this is to be used, the brass frame is fastened with a screw, a paper-covered glass plate is inserted horizontally between the rails, 23, 24, and the pointer is made to follow the contours from right to left, or *vice versa*, whereby half-outlines can be obtained at any level.

This measuring device is completed by an index, 27, marked in centimetres, which is movable, with the sheath in which it rests and the graduated curve, on a vertical rod smooth on the back and marked in front in centimetres, 9; the index can be both rotated and drawn in and out of its sheath (in order to determine the position of certain points on the anterior surface of the body). (See Fig. 123.)

By reading off the dimensions: 1, the length to which the rod has been drawn out; 2, the height at which it stands; 3, the angle around which it has been turned, we can always reproduce the position after the patient has left the stand and transfer the various points to the writing planes by means of the pointer, 17.

Thus any line within reach of the pointer can not only be followed, but may be reproduced on the three plates, and all the drawings thus obtained are projections.

For taking the measurements, the patient, after the line of spinous processes and the scapulæ have been marked, is placed on the board, 1 (which may be covered with paper in order to draw the outlines of the feet), then the toothed rod is inserted, the pads, 2 and 3, are placed against the spines, the pelvis-holders are pressed close, the iron rod is laid against the upper end of the sternum, and the pointer is carried along the line of the spinous processes, when the two writing levers mark on the vertical plates, 19 and 25, giving the skoliotic and kypho-lordotic curvature. Then the outlines of the scapulæ are drawn

and two vertical profiles over the two scapulæ, also the outlines of the figure against the light, and at last some of the horizontal contours, and their extent are measured by one or both levers on the vertical plate. Then the patient steps out of the apparatus and the points measured on the anterior surface of the trunk (projection of the sternum) are drawn. After drawing a vertical line on the sagittal and frontal outlines, and a line parallel to the measuring frame on the horizontal outline, the measurement is finished.

In addition to the ordinary habitual skoliosis, we must take into account the rachitic and static forms. Rachitic skoliosis (which according to Guérin occurs in about 9.7% of children affected with rachitic curvatures) originates from overburdening (unequal effect of pressure) of the rickety (pliable) bone; it usually occurs in the form of an arched (dorso-lumbar) curvature.

The oblique posture when carried on the arm of the nurse, etc., has been mainly considered as the cause of this deformity, and the greater frequency of left-sided skoliosis has been explained on the same theory.

The fact is that in rachitic skoliosis left-sided curvature is much more frequent (9 : 5 Eulenburg, 3 : 2 Heine), the deformity being arch shaped, with the greatest deviation about the middle of the spine.

According to most observers, the two sexes are about equally affected, although some have found boys in the majority. With reference to age, the second year yields the greatest number of cases, that is to say, rachitic curvature begins almost constantly in the first years of life, at the latest up to the fifth year, and the frequency toward the sixth year decreases rapidly (Eulenburg).

As regards the symptoms of rachitic skoliosis, aside from other rachitic manifestations, the predominance on the left side and the arched shape of the curvature should be noted. The vertex of the arch is nearly in the centre of the entire spinal column. The counter-curvatures are high up in the dorso-cervical and below in the lumbo-sacral portion of the spine; the greatest projection of the primary costal eminence lies below the shoulder blade, and hence the differences in level of the scapulæ are less obvious, while a marked prominence of the shoulder in the region of the dorso-cervical counter-curva-

ture is more frequent (Fig. 125). As a rule, in pronounced rachitic skoliosis the costal eminence lies below the left shoulder-blade; in (left-convex) curvature of the median portion of the spine there is moderate (left) displacement of the trunk upon the pelvis, the (left) arm on the convex side hanging free.

In rachitic skoliosis, changes in the pelvis are disproportionately more frequent than in the habitual form; the thorax, too, may exhibit considerable asymmetry, which, however, need not be connected with the skoliosis as such.

The prognosis depends, in the first place, on the fact as to

Fig. 125.—Rachitic (left-sided) Skoliosis in a Boy aged Four Years.

Fig. 126.—Slight Static Skoliosis by Shortened Growth of the Right Leg through Infantile Paralysis.

Fig. 126 a.—The Curvature Compensated by the Addition of a Sole.

whether the rachitic process is still active or has run its course. In general the prognosis is very unfavorable, owing to the age of the infant; in older children of from four to eight years the prognosis from treatment are good.

The term static skoliosis is applied to a primary lateral lumbar curvature which occurs in consequence of depression of the pelvis (*e. g.*, by shortening of one lower extremity), one, therefore, which is a sequel of a disturbance of equilibrium or of effort at compensation. This variety includes Bouvier's hemiplegic total skoliosis, the ischiadic total skoliosis with the convexity of the flat curve to the healthy side described by

Albert, skolioses in consequence of large tumors of the upper extremity, etc.

A great many diseases—arrest of growth, paralysis, osteomyelitic, etc., affections, genu valgum, talipes, etc.—may cause a shortening of the extremity with resulting obliquity of the pelvis, and, through the efforts at preserving the equilibrium, bending of the lumbar spine with the convexity to the depressed side of the pelvis occurs. The observations of Hunt, Cox, Wight, Garson, Roberts, etc., show that unequal length of the extremities is very frequent, the measurements having been made both on the living and on skeletons (Garson). Garson, in measuring the skeletons in the Museum of the College of Surgeons, found the extremities equal in only ten per cent. The variation ranged from one to thirteen millimetres.

It was formerly believed that static skolioses never became fixed, that the night's rest, etc., always effected compensation, and that the graver affections of the extremity limited the function of the leg altogether too much to give play to the static factors; but this is not true for all cases.

It depends upon the duration of the disturbance and the age of the patient whether the curvature will become fixed, *i.e.*, whether permanent anatomical alterations will ensue.

The signs of static skoliosis are easily recognized on inspecting the patient from behind. The physician should sit behind the erect patient and placing his hands on the iliac crests he should determine whether there is any real depression of the pelvis.

Another way is to place the patient by a table and to compare the height of the two anterior superior spines over its edge, when it will be easy to recognize any obliquity of the pelvis and to ascertain the degree of shortening of the one leg by placing a board underneath the foot. The shortening of the extremity may also be ascertained with a tape measure in the horizontal dorsal decubitus, or by a plumb line dropped in the erect position from the anterior superior spine.

Busch[51] measures with a horizontal board having a semicircular segment cut out and provided with a spirit level; the board is accurately applied to two corresponding points of the pelvis, when the deviation of the air-bubble will indicate the obliquity.

The importance of treatment, especially in beginning lateral spinal curvatures, should not be underestimated.

Owing to the great frequency of habitual skoliosis, prophylactic measures are urgently demanded, which implies, of course, some radical changes in our present system of education, especially in girls of the so-called higher classes. While boys, with all the exorbitant demands made on them, still exercise their muscles in their leisure time by tussles on their way to and from school, as well as by walking, swimming, skating, etc., it is different with girls. The latter, even before they attend school, are accustomed to a sedentary mode of life, and with the advent of the school age their training becomes of the faultiest possible nature. The hours of instruction follow in long succession and in the intervals the girl is taught knitting, embroidery, crocheting, etc. The children have barely sufficient time for lunch which must be consumed hastily, for they must hurry back to school, carrying a heavy bag packed with a great many unnecessary books, sit in an over-crowded room, and, when evening arrives, they reach home tired, but must at once prepare their home studies or the mother urges them to practise at the piano. "Modern" children have no more time for playing, jumping, and running in the open air, etc.; the older they grow the greater becomes the number of subjects of instruction, and the less "proper" is it that pupils should be seen romping in the street. If sent to an institution or boarding school, then even the hours of recreation and class walks acquire an almost cloister-like character, which gives them a greater resemblance to a task than to a real recreation.

Although in boys we must grant that all the studies, examinations, etc., open a way to definite professions, and aim at preparing them efficiently for the struggle for existence, in girls, however, we must admit that the examinations, etc., in female colleges are more for the purpose of making an impression, of satisfying maternal vanity, and Lorenz and others justly declare that physicians should never cease to protest against a mode of education which is productive of such a frightful percentage of bodily deformity, even to the extent of crippling growing young womanhood. We must aim for a reduction in home tasks; at least three or four times a week instruction should be given in gymnastics which should consist

less in certain exercises of force or skill than in drill without apparatus; lessons in swimming, common games in the open air, instruction in natural history, geography, etc., with associated excursions, these should be included in the education of our girls. Both parents and teachers must watch over the correct attitude of the children; occupations tending to oblique position (embroidery at the frame, ironing, violin playing, etc.) should be avoided, and children should not be allowed to carry their younger sisters or brothers.[52]

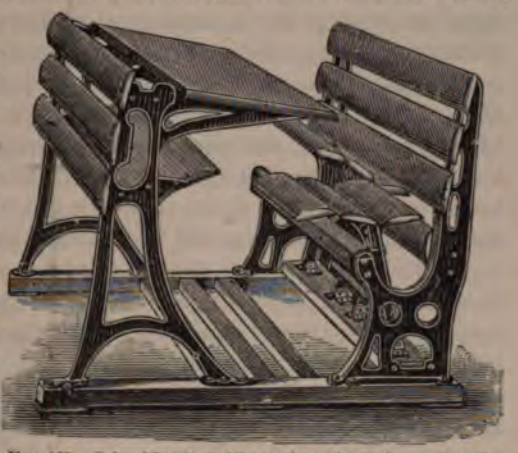


Fig. 127.—School Desk and Seat after Lickroth. The Seat Slides Back on Pising.

When at study, special stress should be laid on a correct position during writing, etc., and now that well-constructed school seats can be obtained (Fahrner, Kunze, Erismann, etc.), a step has been taken in the right direction to guard against habitual oblique position. A correct school seat should answer the following demands: the distance between desk and seat should correspond to the size of the child, and this should amount, in girls, to $\frac{1}{4}$, in boys to $\frac{1}{5}$ of the height of the body, so that the edge of the desk do not reach above the pit of the stomach; the seat should have the proper height ($\frac{3}{4}$ the height of the body, according to Fahrner); the top of the desk should have a slight inclination; the back of the seat should be suitable, preferably one inclined backward with corresponding projection in the lumbar region, or a curved back, or a lumbar rest.

Fig. 128.—Normal School Seat.

The number of desks constructed on these principles is already very large and nearly every exhibition shows alterations and improvements. We must always remember that these changes remove only a part of the objections, and we must emphasize the necessity of sufficient intermissions in instruction, change from sitting to standing, etc.

At home, too, attention should be paid to the correct position of the children, and since modern chairs, even if made higher by a hard cushion, are hardly suitable for children at work, it is preferable to give them chairs specially made for them, such as those devised by Staffel,[53] Lorenz,[54] and others, and which are constructed with arm-rests (Pansch[55]).

Staffel's chair takes the place of a domestic school seat, as it is only necessary to place on a table an ordinary desk top to make the apparatus complete. With some slight alterations it is suitable to children of all ages, and its distinguishing feature is a back-rest, convex in front, corresponding to the normal lumbar curvature, four to five inches high, intended to reach in general from the upper edge of the sacrum to the lower dorsal vertebræ. The height of the chair is calculated for the average height of our tables, and as the child grows the legs of the chair and the foot-rest are correspondingly shortened and the depth of the back-rest is regulated every two years.

Lorenz's work-chair has a back-rest reaching to the upper end of the dorsal vertebræ, inclined backward at an angle of 100°, and curved to correspond with the normal spine; it is covered with cloth or plush. A movable foot-rest is adapted to the front legs. The height of the chair is determined by measuring the distance of the olecranon, the elbow being bent to the surface of the seat and deducting this figure from the known height of the table; by pushing the chair under the table this distance can be easily made negative. Lorenz has also made his chair adjustable, both as regards the height and the back-rest; the several slats of which it is composed can be taken off and regulated, as also the foot-rest.

Others combine the back-rest with a holder carrying axillary crutches for keeping the sitter straight (Kuhn,[56] Vogt,[57] Fürst). Children disposed to skoliosis should also during the day be made to rest for a time in the horizontal position on a well-upholstered hair mattress; for the first indication is un-

burdening of the spine whose resisting power is weakened, and special care should be taken that the child have a suitable bed. It is best to advise the use of a hard mattress with a low wedge-shaped bolster for the head, since feather beds and particularly high bolsters easily lead to a skoliotic curvature.

Further, it is certainly advisable that physicians skilled in the recognition of commencing skoliosis should be attached to schools and should examine the children several times during the year (Lorenz) in order to inform the parents as to the existence of the affection.

As to the actual treatment of skoliosis, which, of course, should be instituted as early as possible, the object is to shift the unilateral weight-pressure, to unburden the spine, and we may distinguish dynamic and mechanical methods. Each of these has its advocates, but usually both methods should be combined, and neither should be employed exclusively.

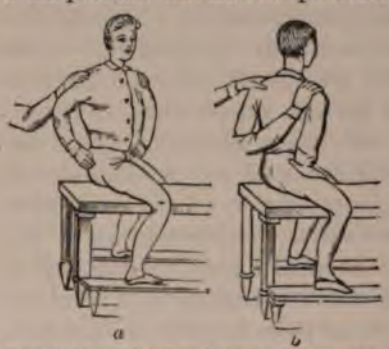
Unquestionably, appropriate gymnastics are very effective in commencing skoliosis and are not only invigorating to the entire system but act especially on the curvature. In children particularly, by means of certain movements and exercises, we can work against the curvature, and counteract any fixation. In the main those positions and movements should be practised which tend to a compensation of the curvature, and the children should often exercise "self-righting." We should particularly recommend exercises with rings hanging from the ceiling which, under certain conditions, may be at unequal height, also on the horizontal pole, trapeze, ladder, etc., especially hanging by the arms with backward curvature, then forward and backward flexion from two rings hanging from long ropes the feet being fixed, circling with the rings, forward flexion between two vertical poles, upward climbing with the hands on the back of the oblique ladder (Busch)—all these are appropriate exercises; so are the lateral (left) raising of the weighted arm, the unilateral deep breathing (the left arm being raised over the head, the right resting on the hip) recommended by Schildbach.

In view of the fact that skoliosis does not occur in persons who, like the English milkmaids, washerwomen, etc., are accustomed to carry loads upon the head, Sayre recommends bringing the patients into a straight position by making them

walk about for some time, at intervals during the day, with a book on the head, thus forcing them to balance the head.

In this connection, mention should be made of the self-suspension recommended by Lee, which is performed for fifteen to twenty minutes several times daily on an occipito-mental strap, with or without the aid of the arms; or, better still, lateral suspension, the so-called self-redressement by lateral suspension (Lorenz[58]).

Busch,[59] Eulenburg,[60] Roth,[61] Saetherberg, and others have also ascribed great importance to Swedish gymnastics with associated opposed movements. These include, with the assistance of a specially trained person, different simple or complicated manœuvres—rising from a suspended horizontal position,



Figs. 129 a and b.—Prophylactic Gymnastics. (After Roth.)

Fig. 130.—Replacement of Skoliotic Dorsal Spine by Lateral Suspension and Weighted Feet. (After Lorenz.)

dextro- and dorso-flexion with raised weighted-rod, etc.—the details of which can be found in the works cited. Figs. 129 a and b show, for instance, the passive torsions of the trunk in the straddle seat. These exercises are to be practised with military accuracy and have a terminology of their own (of which I give only a few, *e.g.*, left-right-stretch-seat, right-stretch-walk, left-support-walk, dorsal-right-lateral-flexion, etc.), and are intended to indicate the exact movements which set some special muscular areas into isolated action.

Great importance attaches also to passive corrective move-

ments, such as diagonal pressure in stretched suspension, high chest suspension, straddle seat, etc., and particularly lateral suspension over a peculiar apparatus according to the method recommended by Lorenz and represented in Fig. 130. (Any carpenter can easily construct the requisite simple apparatus.)

Between two vertical posts, *a*, *b*, about four feet high and forty inches apart, resting on the frame, *c*, *d*, *e*, *f*, is a cross piece, *h*, which can be set at any height by wooden pins, *g*. The centre of the cross piece is given the form of a half-cylinder by superimposed slats and is upholstered with horse hair or covered with velvet or plush. The half-cylinder, *i*, is about thirty inches long and five inches broad. One cross rod of the frame carries a leather strap, *l*, with a handle, *k*, which may be buckled at any desired height. (A cheap substitute for the apparatus may be formed by fastening a cross piece, upholstered, between two door posts, together with a long rope tied to a screw hook in the floor.)

The patient grasps the handle with the left hand, places the right foot on the step, *m*, and then lies on the padded centre piece so that the prominent crest of the ribs, *R*, bears with its greatest convexity vertically on the pad. Thus the skoliotic trunk is suspended, as it were, upon the costal eminence, and when the patient allows the foot to glide off the step, the body represents a two-armed lever, so that the recurvation is effected with a force corresponding to the weight of the body, and this weight may be increased by suspending bags of shot from the ankles, *o o*, after the patient has become accustomed to the lateral suspension. Lorenz points out that lateral suspension should not be entrusted to the child before it has become accustomed to the correct placing of the trunk, and that the position is correct only when the right diagonal diameter of the thorax is vertical to the pad. The hand of the physician may increase or modify the force. Lorenz also states that the first attempts are painful, that disturbed respiration is sometimes present, and that weeks elapse before the patient becomes sufficiently accustomed to the procedure to bear it with comparative ease.

Beely[62] has devised a very simple apparatus, essentially in the shape of a long, right-angled frame. Resting on two stout posts, it may be revolved around a central axis, has superior cross rods to be grasped at different heights by the

patient, and has two movable pads which can be so applied to the body as to effect diagonal recurvation. By depressing the upper part of the longitudinal frame, the force exerted by the weight of the body can be graduated, and the length and frequency of the exercises are regulated by the endurance of the patient.

Shaw devotes a chapter to the consideration of the proposition to cure curvatures of the spine by friction, kneading, and shampooing, together with a picture of a special frictional roller. The advocates of the myogenous theory of course claimed that massage with electricity and gymnastics were deserving of the first consideration and these means have also been employed in suspension (P. Vogt). Of late, this plan has been again warmly recommended, especially in the form of pounding and rubbing of the dorsal muscles on the two sides—massage of the thorax.

Landerer[63] thinks it important that the physician should perform the massage himself and reports striking results after several weeks' treatment; so do Kölliker and others. It is advisable to cause the patient to wear a corset in the intervals.

In order to strengthen the weak dorsal muscles which allow the habitual lax attitude, the faradic current has been recommended (L. Vogt and others), not only for the production of vigorous contractions of the dorsal and thoracic muscles with the associated increased contractility and nutrition, but also for obtaining appropriate positions and movements in isolated portions of the spine.

Important as these methods are from the standpoint of prophylaxis, and in the treatment of commencing skoliosis and in mobilization of advanced, little effect can be expected of them in fully developed cases. In the latter, mechanical auxiliaries must be resorted to which are based either on traction and counter-traction or pressure and counter-pressure. They may be divided into couches and portable apparatus (corsets, etc.).

It is of the utmost importance to utilize the night's rest in the treatment (all the more because one disturbing element, weighting, is eliminated), and the first care should be to provide a hard mattress.

A simple device for overcoming the curvature is the Lonsdale-Barwell suspensory sling (the suspensory belt) (Little,

Schildbach, Busch[64]). This is a sling hanging by a rope from the ceiling at the proper height over the bed, into which the patient places himself on the convex side, whereby pressure is exerted in a correcting diagonal direction or a lever effect is produced. Busch and Wolff have modified the method of lateral pressure by a suspensory belt, by applying the belt, hand wide, to a special support (a base board with two pair of obliquely ascending iron rods), thus making a suspensory frame.

Its only drawback is that its effect is at once nullified if the patient turns in it.

Rest for several hours daily in a hammock can also be used; for instance, in right-sided deviation the patient should

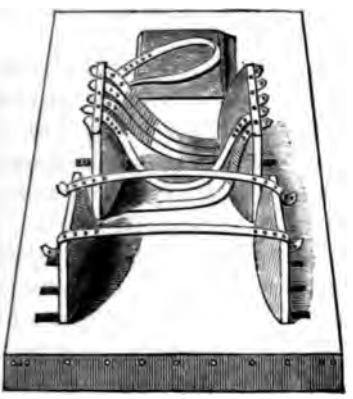


FIG. 131.—Beely's Couch for Skoliosis.

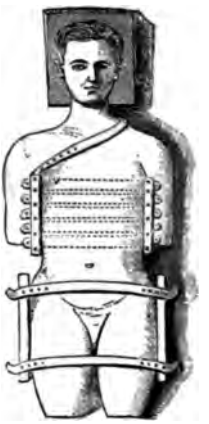


FIG. 132.—Beely's Couch. (Representing the Position of the Patient.)

lie with the left side down, thus changing the concave side into the convex, that is, reversing the condition.

Next in order are the couches for skoliotics, of which the one devised by Beely,[65] represented in Fig. 131, may be adapted to any individual and may easily be made by any mechanic. In a right-angled bed, upon which the patient rests, are two excavations for the head and pelvis over which straps are stretched; four smaller boards are fastened vertically with angle-irons; two of these reach from the axillæ to near the iliac crests, two extend to the middle of the thighs, their height being equal to the sagittal diameter of the thorax.

The boards are padded on the inside and those for the thorax rest on but three points, so that straps can easily be carried under them. Near the upper outer edge each has five or six equidistant buttons for attaching the straps. Two buttons are applied to the head end for attaching a neck-strap. For a patient with right dorsal left lumbar skoliosis five straps are applied; only one of these (4) is of leather throughout, the others have a piece of stout rubber interposed. The upper straps run from right above to left below, the fourth forms a simple suspensory belt, the fifth runs from left above to right below, and when the patient places himself in the apparatus the pelvis is fixed by two transverse straps, the neck is prevented from bending to the left by a well-padded strap, and straps exert an elastic corrective pressure on the most prominent parts of the back. A low pillow may be placed under the head.

A couch which is largely used is that of Bühring—an iron plate carrying pads adjustable by screws to bear against the convexities of the curvature. Hüter's modification[66] of this apparatus still has its advocates. Schildbach used, instead of the wedge-pads, traction pads, and Staffel[67] has devised a combination of Bühring and Schildbach's apparatus. He used the wedge-pad for the lower curvature and for a dorsal pad a broad oblique belt connected with a strongly curved steel spring; all these parts are adjustable, as is a third padded brass plate. When the straps are buckled, the spring acts, the pad is pressed in front against the ribs and a rotatory effect is produced by the combination.

A variety of apparatus acting by traction and counter-traction has been constructed since the time of Hippocrates, in the shape of the extension beds of Venel, Heine, Valerius, Moncour, Guérin, Bouvier, Pravaz, Major, Coles, and others. On these the poor patients were formerly tortured for years without effect, so that Wildberger justly condemned them. From the large number we select only that devised by Heather Bigg, which will be readily understood from Fig. 133 and which permits at least some movements, while the elastic appliances exert constant traction, correcting the curvature; and we also show the simple extension frame of Beely[68] which may be used in connection with other methods (in the intervals of rest). (See Fig. 6.)

The numerous orthopedic chairs devised since the time of Levacher de la Feutry have merely an historical interest.

Of importance, especially for static skoliosis, is the anti-static treatment which aims at a correction of the lumbar or

FIG. 133.—Heather Bigg's Extension Bed.

other curvature by causing an oblique position of the pelvis. By the interposition of a cork sole, not over one and one quarter inches thick, on the side of the convexity (*e.g.*, on the left in left-convex lumbar curvature) the pelvis is made to incline to the right and the curvature is compensated; but care must be taken lest bending of the knee counteract the effect of the measure. This method of course is applicable only to mobile skoliosis.

Lorenz[69] has attained very effectively the simultaneous correction of the dorsal and lumbar curvature in the erect

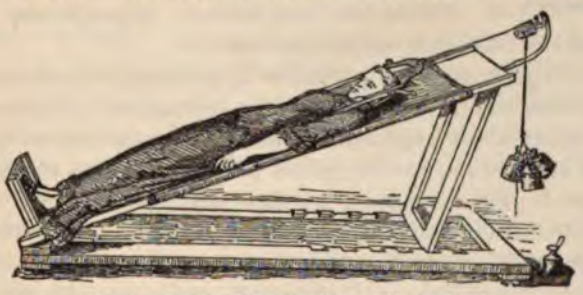


FIG. 134.—Beely's Extension Frame for Skoliosis.

position of the patient as follows: A well-padded pelvic fork, fastened at the proper height in a vertical post, grasps the pelvis of the patient at the level of the spines and is closed by a padded strap.

By placing the left foot on a rest one to one and one-half inches high, the pelvis is depressed on the right, the left-convex lumbar skoliosis is bent back, and the thorax being surrounded by a padded belt and fastened to the vertical pole, is pressed to the right and the head is inclined to the same side. It is thus possible to attain correction, and after frequent repetition and intensification of the belt action, the dorsal skoliosis may be even slightly over-corrected. By weighting the shoulders by a collar filled with shot (60 to 65 lbs.), a marked over-correction can be effected (the line of spinous processes being closely watched).

In the sitting position, particularly, it is possible to attain the desired end by elevating one half of the pelvis. Volkmann and Barwell have devised for this purpose the well-known oblique seat (Fig. 135) to which Vogt has added a suspender. This seat may be improvised by a wedge-shaped oblique cushion. According to Staffel, this apparatus can be easily made portable by being attached to the corset in the shape of a small wedge-shaped bolster.

Fig. 135.—Volkman's Oblique Seat.

König and others recommend testing the effect of the oblique seat on the back of the patient before advising its continued use.

A lady's saddle also represents a similar oblique plane and under certain conditions riding is considered appropriate in the treatment of skoliotic female patients.

The large group of portable apparatus, the corsets and girdles, which merely keep the spine extended or are intended to act by measures (pressure and counter-pressure) specially directed toward correction, must be conjoined to the above in the more highly developed forms; but we must not restrict ourselves to their use and neglect gymnastics, etc. The number of skoliosis apparatus is enormous and their close description would fill volumes; I therefore must restrict myself to some in present use, especially since Fischer[70] has only recently published a careful synopsis in historical order, to which the reader is referred.

The apparatus which acts by elastic traction devised by Barwell[71] has the advantage of great simplicity; but it can

only exert elastic lateral pressure, and has no torsional power.

In the elastic traction apparatus (the oblique bandage) constructed for habitual skoliosis, the line of traction, rendered elastic by rubber bands, is from the left trochanter to the projecting portion of the ribs and from there to the left shoulder. The latter, as Busch points out, may have an injurious effect by drawing the left shoulder with the entire trunk to the right side—an evil which Heather Bigg tried to overcome by adding an axillary crutch ascending on the left side.

In Barwell's elastic spiral bandage, which starts from the region of the right trochanter where a soft leather pad is fastened by a perineal belt, passes obliquely over the abdomen to the prominent ribs and thence to the left shoulder, encircling the body spirally, there is not a sufficiently fixed point for the force to act. Sayre's [72] modification of Barwell's oblique bandage—of which the author himself says that it is rather a monitor to the patient—and which consists of the addition of other elastic lines of traction, two perineal straps, etc., will hardly make the apparatus more useful, exerting as it does a correcting elastic lateral pressure, but no rotatory power.

Fig. 136.—Barwell's Spiral Bandage for Skoliosis.

By his elastic spiral bandage (which has not yet been sufficiently tested in practice) E. Fischer applied elastic torsional traction immediately to the body. The apparatus draws the shoulder corresponding to the convex outward curvature (hence usually the right) downward and forward, and by increasing the pressure on the convex side, restricts its growth.

The contrivance has the advantage of being cheap, easily constructed, permitting gymnastics, massage, etc., while causing hardly any pain from pressure, etc. It consists of a leather (right) shoulder-holder, narrow in front, becoming rounded, and deeply cut out, which is intended to reach the mid-line and to cover below the outward curved portion of the spine; it is fastened by an elastic bandage around the shoulder of the concave side (left)—Fig. 137—whereby this (left) shoulder is

steadily drawn backward but not downward. From the shoulder belt two elastic bandages pass which leave the (right) breast free, extend over the abdomen to the (left) thigh where

Fig. 137.—Fischer's Spiral Bandage, Applied with good effect to the Girl Represented in Fig. 119.

Fig. 138.—Beely's Supporting Apparatus, Lateral View

they are fastened so that when the left hip is lower the pelvis is constantly kept straight.

The great majority of the numerous skoliosis appliances consist in an upholstered pelvic belt which forms the point of

Fig. 139.—Beely's Corset.

Fig. 140.—The Same, Rear View.

support; it rests above the anal fold between the iliac crest and trochanter (occasionally with special auxiliary supports above the crests), and is buckled in front over the symphysis pubis.

From this ascend, either behind or also laterally, one or two steel splints, to the former of which are fastened belts or pads for the correction of the costal eminence, and to the latter axillary crutches (props) for stretching the spine. Hossard, Tavernier, and others have been mainly instrumental in the introduction of the corset treatment.

Particularly for slight cases is it advisable to use, in addition to appropriate gymnastics, massage, etc., simple supporting apparatus for the spine—corsets made of strong material, fitting well at the waist, and supplied with whalebone or steel plates and arm props. Fig. 139 represents a suitable corset of the kind devised by Beely,[73] Fig. 140, the same seen from behind; while Fig. 138 represents the mechanism for the gradual elongation of the lateral splint. According to Beely, it is sufficient in most cases to model only one lateral splint (for the convex side of the thorax) and have the other made exactly symmetrical; in grave skolioses a special model must be made for each side, and the length of the arm props be exactly regulated.

Fig. 141.—Beely's Supporting Corset in a Case of Grave Skoliosis (Comp. Fig. 182).

Beely's axillary props are rarely lengthened behind above the lateral splints, and in fact consist merely of the anterior half of the ordinary form of axillary crutch, and end in axillary straps; they are made either of quarter-inch iron wire padded with soft felt so as to be still slightly flexible, or of square steel rods, in which case they must be given their per-

manent form before being hardened. The lateral splints, about one-half inch wide, one-eighth to three-sixteenths inch thick, carry only the extensible arm prop; they are but slightly elastic, pass vertically down from the centre of the axilla, and above the crests of the ilia are bent forward.

The back of the corset is provided with vertical elastic steel splints of varying length and thickness, so shaped as to exert a correcting effect on the most prominent parts. At the upper end of each lateral splint are three, at the lower ends two buttons, and at the level of the waist one on each side, which serve for fastening the back straps, breast straps (below the mammæ), and two abdominal straps (uniting the

Figs. 142 a and b.—The Latest Form of Beely's Corset for Skoliosis.

ends of the lateral splints). In front and behind the corset is made to lace; the anterior splints on each side of the lacing openings consist of three parallel steel wires one-sixteenth of an inch in diameter, inserted above and below in a small metal sheath; they bend in any direction and hence are always closely applied to the body.

Where necessary, elastic traction may easily be added over the greatest convexity.

The latest modification of Beely's corset, Figs. 142 a, b, has two lateral splints which are joined only on the left side by the crutch; the dorsal splints are almost inelastic in the middle, very flexible above; at their lower end they are flat; the lateral splints are strongest at the waist. The upper, median,

and lower parts can be laced unequally tight (the median portion to the greatest extent).

The belt originally devised by Hossard aimed only at redressing the deformity, offered no support to the spine, and could be of slight use only in simple skoliosis, but would be rather injurious in more complicated forms (Bouvier, Volkmann).

Hossard's belt in its simplest form consisted of a broad, well-padded pelvic belt; from its posterior portion ascended a stout median iron rod as far as the shoulder; it was movable by a toothed wheel, could be fixed to the right or left, and carried small buttons on its posterior surface. The buttons served for attaching padded leather straps which passed in a semi-spiral from behind over the prominent shoulder blade and the costal eminence to the front, where they were buckled. The steel rod was to be so adjusted as to bring its upper end to the side of the dorsal convexity alongside the spine, crossing the latter obliquely; the straps in the ordinary habitual skoliosis were to be so drawn as to shift the entire thorax to the left.

Tamplin[74] modified the apparatus by adding an axillary prop on the concave side of the curvature.

Guérin[75] put a hinge into the posterior rod and added a corresponding anterior splint, so that the strap between the upper portions should act on the dorsal curvature, that between the lower portions on the lumbar curve.

Mathieu's apparatus, similar to that of Duchenne,[76] devised especially for skolioses succeeding muscular paralysis, represents a belt acting by elastic cords; the lower shoulder is raised by an axillary prop, and the deviation is counteracted by elastic straps which may at will increase the inclination of the posterior steel rod and thus press the broad belt against the dorsal convexity.

Additional more complicated modifications have been devised by Charrière (*ceinture à pression continué*), Wales, and others.

In Brodhurst's apparatus the movable dorsal rod is united with the axillary props in the region of the shoulder blades, from it extends a lever with large pad to the side of the convexity where it exerts inward pressure, while the lower shoulder is surrounded by a well-fitting cap of rubber which is fastened behind to the upper end of the dorsal rod.

Volkmann[77] recommended, especially for slight unilateral skoliosis of static origin, a simple apparatus which consists, in ordinary right-sided skoliosis, of a pelvic belt with left thigh splint, left axillary prop, and a median rod with slight spring action to the left. From the upper end of the latter an elastic belt, broad enough behind to inclose the entire prominent part of the back and the shoulder blade and then becoming narrower, passes over the abdomen and the left crest of the ilium to the pelvic belt, where it is fastened behind the trochanter, so that the apparatus exerts a slight rotatory effect.

Fig. 143.—Mathieu's Modification of Hossard's Belt (for Left-sided Skoliosis).

Fig. 144.—Staffel's Belt.

Finally, a very simple and practical modification of Hossard's belt has been devised by Staffel.[78] He employs a spiral rubber bandage, the broad end of which springs at a right angle from the upper end of the vertical mast which follows the outlines of the body. The bandage curves around the prominent (right) dorsal side, passes in front obliquely over the abdomen to the opposite (left) side, which it surrounds, and is fastened behind by two straps. The mast may be applied either at the posterior centre of the pelvic belt or to one side, as it can be shifted along a slit and fastened by a thumb screw so as not to interfere with bending of the body. A spring piece, *a*, is placed in the mast at about the level of the lumbar curve, while the upper end rests against the back with slight elastic pressure. A thigh strap prevents upward dis-

placement of the pelvic belt on the left side, and where the height of the shoulders remains uneven, an axillary prop is added on the concave side.

In place of the median rod, Eulenburg, Heather Bigg, Chance, and others recommended two masts adjustable by an endless screw to which the correcting straps or pads are fastened.

One of the most extensively used appliances is that of Goldschmidt-Eulenburg (Fig. 145) with spring axillary props,

FIG. 145.—Apparatus for Skoliosis. (After Goldschmidt-Eulenburg.)

FIG. 146.—Schildbach's Lateral Traction Machine.

b; behind it carries a stout steel splint, *c*, reaching exactly to the centre of the back and fitting closely to the body, at the middle and end of which is a toothed-wheel. From these ascend to the right and left round steel rods which can be given a lateral motion by turning the screws with a key and which carry the two pads, *d*, for surrounding the convexities. The pads are movable forward, backward, up and down. The apparatus may be stitched into an ordinary corset, does not annoy the patient, extends the spine by the spring axillary props, and is intended to redress the curvatures by the elastic pressure of the pads. One modification substitutes elastic straps for the pads.

Another group of apparatus, like Schildbach's portable

lateral traction machine, applies the traction or pressure more in an oblique direction.

In ordinary right-sided skoliosis the left shoulder is raised by an extensible axillary prop which forms with the pelvic belt an angle open to the inside, so that, before the chest straps are laced, the upper end points away from the thorax; after being laced an elastic lateral traction is exerted from right to left. A strap carried over the left shoulder is to prevent deviation of the pelvic belt.

Lorinser's[79] apparatus is also intended to crowd the convexity of the dorsal vertebral curvature toward the middle line by elastic traction. To the pelvic belt is adapted a splint, movable on a hinge, along the opposite thigh (the left in right-sided dorsal skoliosis), which reaches to the axilla and when fastened to the thigh by straps it tends to deviate to the left above. If fastened above by a broad leather belt which surrounds the prominent (right) side and below over the abdomen to an iron tongue connected with the splint, a correcting effect is exerted. Displacement of the splint is prevented by a crutch-like attachment above, and an axillary prop is also applied to the opposite side.

Another apparatus having mainly a lateral effect (hence unsuitable where torsion is pronounced) is that of Goldschmidt,[80] in which endless screws exert pressure on two pads on racks, applied against the main curvatures, thus aiming at reduction.

Of more importance are the numerous apparatus acting also upon the torsion.

Langgaard's[81] apparatus consists of a well-padded pelvic belt composed of two parts and closed in front by a hinge; it rests by two steel arches on the crests of the ilium. On the concave side is an adjustable steel rod with axillary crutch and from it extends a jointed spring arm. At the end of the latter is a pad adjustable by a ball-joint to any portion,[82] intended both to redress the torsion and to exert direct pressure on the projecting parts; it is moved by an endless screw. For producing counter-pressure, a steel rod is on the convex side with interposed spiral spring for adapting it to the movements of the arm; at its extremity is a rounded pad for the anterior region of the shoulder. Straps passing over the shoulders help to fix the apparatus.

The apparatus devised by Heather Bigg[83] also has pressure pads. From a light pelvic belt, somewhat oblique in front, corresponding to the inclination of the pelvis, ascend one or two posterior, well-padded steel splints which carry, at the level of the shoulder-blade, a cross rod with two curved portions which surround the axillæ. At the proper height of the dorsal splint, pads are fastened which exert a redressing effect, through spring or screw pressure, on the deviations. Chance has devised a simple apparatus, largely used in London, which for slight cases consists of a pelvic and lumbar belt,

FIG. 147.—Apparatus for Skoliosis. (After Langgaard.)

FIG. 148.—Apparatus for Skoliosis. (After H. Bigg.)

median dorsal splint and pad against which the shoulders are pressed; for graver cases two pads are added for the dorsal costal eminence.

Another apparatus, devised by Heather Bigg for grave cases, acts mainly on the torsion and aims at twisting the thorax on the pelvis by means of a spring ascending on the left from the broad pelvic belt across the mid-line to the right above, which presses by a broad pad upon the right costal convexity. Aufrecht with his apparatus endeavors to press by one pad the posteriorly projecting right shoulder forward, and the forward protruding left shoulder backward by another pad (Fig. 149).

Of the numerous pad corsets, Nyrop's spring pressure machine[84] is justly one of the most popular and is preferable to others also on account of its slight weight.

The apparatus consists of a pelvic belt from which ascends in the mid-line of the back an iron rod which carries above, on an adjustable cross-piece, two axillary crutches ending in straps for fixation. To the dorsal rod are fastened an equal number of steel springs tending outward, *i.e.*, convex in front (they should preferably be compound springs), each of which carries a movable pressure pad and these are fastened in front by straps so that the pad exerts a correcting action on the convexity. For the lower (left) shoulder the machine is supplemented by a lateral splint which, according to Jessen's proposal, should be forked below and be arched over the iliac

Fig. 149.—Apparatus after Aufrecht.

Fig. 150.—Corset after Trélat.

crests, being fastened at the pelvic belt. The lumber pad may also be replaced by an elastic strap with corresponding obliquity. Vogt and others prefer Nyrop's corset to any other. As for the good results attained with this apparatus, the reader is referred to Nyrop's paper.[85]

Collin's apparatus (with pelvic belt, lateral axillary props united by a metal frame) is also provided with devices for exerting elastic pressure on the projecting parts of the body, similar to the apparatus of Trélat and Le Fort, the lower parts of which consist of pliable sheet copper closely fitting the body, or of shaped leather.

Some of these apparatus may also be looked upon as modifications of Hossard's belt, like Mathieu's apparatus after Trélat, represented in Fig. 150.

Staffel,[86] too, has recently devised a pad corset which, for the common (right-sided) skoliosis, consists of a pelvic belt of sheet steel, an axillary prop for the lower (left) shoulder, and a splint extending from the (right) posterior circumference of the pelvic belt, adjustable by an endless screw, and provided above with a hollow pad; in other respects it is a strong whalebone corset to be laced in front. By means of it we can exert any desired pressure on the posteriorly projecting ribs, and thus produce a forward twisting effect; while the right shoulder band being drawn tauter, the higher shoulder is depressed.

In the latest corset of Nyrop, which he much prefers to the plaster jacket, the apparatus is provided with appropriate (jointed) steel springs capable of exerting pressure on the body from without inward. The apparatus is removable, but may be worn day and night; it may also be easily combined with Levacher's swing, as may be seen from Fig. 95. The apparatus fits the body as closely as a plaster jacket, and thus in many respects resembles the above-described corset of Beely.

We may gather from the large number of apparatus for skoliosis that their corrective effect is by no means prompt, and some authors (Sayre, Dally) reject them all. Sayre at all events goes too far in rejecting all such apparatus as useless and as merely forcing the patient to bear horrible torments.

At any rate, their disadvantages—that they are expensive, cannot be used long, and need frequent repairs—are apparent in most of them, and hence it is easy to understand the delight which greeted Sayre's announcement that he had found in the plaster corset applied in suspension a method of treating skoliosis which was accessible to any physician.

But soon the original enthusiasm gave place to sober afterthought, and nowadays all that can be said is that the plaster jacket, applied in specially redressed position and made removable, is of importance in skoliosis only when used in connection with other treatment. Plaster jackets worn too long may act injuriously by causing atrophy of the muscles, etc., and, important though they are for kyphosis, they are unsuitable to slight skoliosis, and Dollinger[87] has demonstrated by measurement an increase of slight skolioses in the plaster jacket. Constructed as removable retention dressings, however, they are of importance in severe cases, seeing that

they liberate the thoracic and abdominal organs from the weight of the trunk, and facilitate the equalization of the circulation. The plaster of Paris, however, should act here only as an adhesive material for the bandages and merely be rubbed into the gauze rollers (about three and one-half inches broad). The plaster mass cannot be employed; and the dressing, which is applied over a tight-fitting stockinet shirt, has decided advantages over others in that it sets rapidly.

Silicate of soda corsets have the advantage of being more durable; but the first bandages applied over the stockinet shirt must be well wrung out, otherwise the silicate penetrates into the shirt, making it hard and rough, and possibly giving rise to excoriations, etc.

The application of the corset in suspension is not as handy as in the hammock method or in reduced lateral position (Dornblüh, Petersen,[88] Fränkel).

Petersen places the patient as follows: The legs are supported on a table as far as the trochanters, the head rests on a pillow on another table, the trunk is supported only at the greatest convexity by a Barwell's sling, *i.e.*, a triangularly folded cloth the ends of which are fastened to a cross rod which is drawn up or let down by pulleys. After the position has been corrected or over-corrected and the spines padded, the sling is included in the plaster dressing and the ends are cut off.

Lorenz has devised definite methods of applying removable plaster dressings for the several forms of skoliosis; they are intended to supplement the result attained by methodical correction and to maintain position; thus, for primary dorsal curvature there is the lateral traction dressing and pressure dressing (the former, of course, acts only against the lateral curvature of the spine, leaving the costal curvature out of consideration, while the latter is specially directed against the ribs).

The lateral traction dressing (Fig. 151), *i.e.*, a plaster dressing fixing the trunk in left displacement to the pelvis, with the addition of traction at the thigh, is suitable to somewhat advanced primary dorsal skoliosis with considerable lateral displacement of the trunk on the pelvis toward the right. Owing to the disfigurement caused by wearing it, it is applied several hours daily at home, in such a way that the lateral

displacement is quite considerable, forcing the child to active opposite bending of the spine, while for use outside it is advisable to apply a less conspicuous dressing which causes only slight lateral displacement.

The lateral traction dressing is applied in the erect position, the pelvis of the patient between trochanter and iliac crest being grasped by a padded pelvic fork; the trunk is first brought into the desired position or fixed by a belt attached to a lateral vertical post and surrounding the thorax. The right arm being abducted, the plaster dressing is applied. It reaches above only to the point of the right shoulder-blade; on the left side it may be still shorter. The pelvic folds of the bandage inclose a two-armed tin plate having grater-like openings and bearing below a stout ring; to the latter is fastened, after completion of the dressing, a strap arising at the left from a legging laced to the thigh which serves to prevent displacement of the left lower edge of the dressing.

Fig. 151.

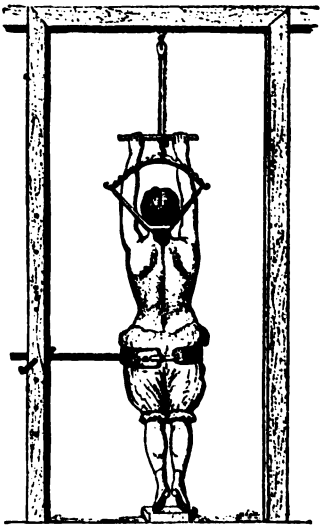


Fig. 152.

The pressure dressing, which is directed especially against the torsional changes of dorsal skoliosis, is applied by Lorenz like an ordinary Sayre's jacket; the patient being suspended in Beely's sling, and the pelvis being fixed by a fork, *a* (Fig. 152), so as to prevent rotation of the body. The dressing reaches to the angle of the shoulder-blades, the flat parts of the thorax having previously been padded with felt placed under the

stockinet shirt. Over the most prominent points thick felt pads are fastened to the inner surface of the dressing, which, when completed, is laced in suspension. Thus pressure is exerted in the right diagonal diameter, while dilatation of the thorax is permitted in the shortened left diagonal diameter.

It is easier to effect correction (or fixation of the affected segment in a position opposed to the curvature) in case of lumbar skoliosis, by using a still lower and hence less troublesome removable plaster dressing. This dressing Lorenz recommends, as the "belt dressing," for primary lumbar skoliosis, and at the same time it has a correcting effect on the commencing secondary curvature of the dorsal segment.

This dressing is also applied in the erect position. In left

Fig. 153

Fig. 154.

lumbar skoliosis the left side of the pelvis is raised by elevating the foot three-fourths to one and a half inches high, is fixed by the pelvic fork, the trunk is inclined to the left and supported by a padded axillary crutch. This position the patient can readily maintain for fifteen to twenty minutes; then the plaster dressing is applied in the usual manner and thus the lumbar spine is maintained in a right-convex position; in left-inclination of the trunk the dressing is applied or laced from the right side.

Karewski,[89] at Israel's instigation, recommended corsets made of close-meshed galvanized wire netting, or plates for the anterior and posterior surface of the trunk, with proper openings for the arms and moulded to fit the mammæ; they are accurately fitted to the patient in suspension or other-

wise. These wire plates, the borders of which are lined with strong adhesive plaster, are united into a corset by means of a silicate of soda bandage which is applied in suspension. After twenty-four hours the corset is opened at the side and removed, when the edges are bordered with soft leather, one lateral edge is provided with hooks for lacing (with rubber cord), the other is made flexible by a stout strip of leather, and on each shoulder, front and rear, hooks are affixed for elastic shoulder straps (a piece of rubber two inches wide, with perforated leather straps at each extremity).

These wire corsets are said to be preferable to the plaster jacket on account of their better fit, light weight, porosity, and durability; only a close-fitting stockinet shirt should be worn underneath; they should be removed at night and applied in the morning in suspension.

Of still simpler material are Bernhardi's pasteboard corsets which may be reinforced with splints, and Vance's[90] paper jacket which is formed of strips of brown paper glued together.

Corsets of plastic felt have also been used. They are shaped directly on the body or on a model; but they are much inferior to steel spring corsets and are valuable only in case of skoliosis of the third degree, in which some supporting apparatus must be worn for preventing neuralgic pains; they are applied in suspension.

Deformities of the Thorax.

Pigeon breast, *pectus carinatum s. gallinatum,* is the term applied to a characteristic deformity of the thorax (with or without implication of the spine), in which the anterior ends of the ribs are bent inward, the sternum and costal cartilages project in the shape of a keel, the thorax being enlarged in the sagittal diameter, and narrowed in the frontal diameter.

The costal cartilages being bent inward with concavity directed forward, a sulcus is formed on both sides in front of the thorax.

The deformity usually depends upon rachitic softening of the bones, but other processes may be concerned in the etiology, though more rarely, and Eulenburg, *e.g.*, distinguishes:

Pectus carinatum rachiticum,
" " ex gibbositate,
" " paralyticum.

That pigeon breast is among the most frequent of rachitic deformities is shown by observations such as those of Chance, who observed 156 cases among 600. Besides primary local softening of the bones, there are a number of other causal conditions to be considered, such as those which prevent the free entrance of air into the thorax, especially attacks of spasm of the glottis associated with soft occiput (Elsässer); for in these cases the glottis does not open far enough to permit the ingress of air with sufficient rapidity to meet the sudden enlargement of the thorax by the action of the diaphragm. The air pressure then acts on the sides of the thorax and crowds the weakest portions inward (Jenner, etc.). Besides spasm of the glottis, there are other conditions in which the expansion of the thorax is not accompanied with sufficient dilatation of the lungs; paralytic states (after whooping cough, etc.) are also mentioned as etiological factors, as well as enlarged tonsils (Shaw).

Fig. 155.—Severe Pigeon Breast with Paralytic Lordosis and Kyphosis; Bilateral Spontaneous Luxation of the Hip.

Further still the lateral pressure of the arms upon the chest may play a part in the formation of pigeon breast.

With reference to the symptoms, we observe here, too, widely differing grades of the deformity, and in the higher of these the lateral flattening of the thorax with the keel-like projecting sternum and flattened costal cartilages which form a real hunch-breast constitutes one of the most terrible disfigurements (Fig. 155). The thorax at the same time is considerably shortened in its transverse and lengthened in its sagit-

tal diameter, its capacity is absolutely diminished, and hence in the graver cases some dyspnœa is rarely absent, especially if spinal curvatures coexist.

The prognosis is favorable only in the slighter grades in early infancy, since in the course of growth, after the rachitis has run its course, a spontaneous compensation of the deformity is here also possible; in the higher grades, of course, the prospects of improving the deformity will become worse.

The treatment (in addition to being anti-rachitic) must counteract the narrowing of the thorax by appropriate active exercises and gymnastics (some exercises, such as rowing, are here specially recommended) and by stimulation of the inspiratory muscles (baths, cold affusions, etc.).

Of course, circular bandaging of the thorax cannot be resorted to, but the application of weights (shot bag, etc.) to the anterior surface of the chest in the dorsal position may be tried. Passive exercises may be performed methodically several times daily and be productive of good results; only rarely will resort be necessary to more complicated apparatus which approximate the sternum to the spine by elastic pressure without touching the lateral wall of the thorax.

In comparison with pigeon breast, other deformities of the thorax are of minor importance. A characteristic deformity, also usually due to rachitis, is the *pectus excavatum* with depressed sternum or in-drawn præcordium (similar to that occurring as the result of some occupations, as in shoemakers, etc.). These varieties are entirely beyond the reach of treatment.

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CHAPTER V.

ORTHOPEDIC AFFECTIONS OF THE EXTREMITIES.

I. Contractures and Ankyloses.

The term ankylosis (from ἀγκυλος, crooked [1]) (French, *roideur articulaire, anchylose;* German, *Gelenksteifigkeit, Gelenkverwachsung;* Italian, *anchilosi*) designates that condition in which, through adhesions or other alterations within or without a joint, its mobility is partly or entirely arrested.

It is customary to distinguish complete, true, bony ankylosis, where the articulations are united by bony adhesions (synostosis) and where mobility is therefore completely arrested, and false, partial, fibrous ankylosis, in which the adhesion is effected by connective tissue and a partial mobility is retained. Some distinguish, in addition, cartilaginous ankylosis which arises mainly from inflammatory processes in the neighborhood of joints, resulting in gradual obliteration of the synovial membrane, and in which the cartilaginous layers at first remain intact, but become subsequently adherent and atrophic.

Bridge-like ankylosis is the term applied to the condition in which the ends of the articulations are united only by some flakes of bone, which usually correspond to the ossified fibrous ligaments or muscles, as for instance, the anterior longitudinal ligament of the spine, the brachialis internus at the elbow, etc.

Furthermore, we may distinguish straight or angular, simple or complicated (*e.g.*, associated with luxation) ankylosis.

In general, the term ankylosis is understood to mean the condition of absolute immobility (*immobilitas compacta*) of a joint, while diminished mobility, pathologically restricted excursion of motion (*mobilitas incompleta*) is designated as contracture (pseud-ankylosis, *rigiditas articuli*). The latter is divided into the arthrogenous, *i.e.*, that due to changes in the articular apparatus, into the neuro-myogenous, *i.e.*, that due

to alterations in the muscles or their innervation, and into the cicatricial which are caused by cicatricial processes, the contraction of cicatrices. We will speak of the neuro-myogenous contractures mainly under the head of deformities produced by paralytic conditions, etc., and we are at present chiefly concerned with the arthrogenous contractures, and with those due to pathological processes around the joint (peri-articular) which include also the cicatricial contractures.

Congenital contractures and ankyloses as the result of arrested development, or in consequence of inflammatory processes *in utero* rarely come under observation. We find, however, for instance, in the *Histoire de l'Académie des Sciences*, 1716, the description of a child aged twenty-three months with complete ankylosis of the entire skeleton.

Ankylosis is observed much more frequently in ginglymoid joints than in others; usually it is found in a single joint, rarely in several. Cases like that reported by Conner (*de stupendo ossium coalitu*), in which there was an almost universal ankylosis, are very exceptional.

As to the causes of contractures and ankyloses, they may arise gradually from simple non-use, especially in elderly persons, as has been demonstrated by Menzel,[2] Paget, Reyher,[3] and others. An interesting example is furnished, among others, by the Indian fakirs who, for the sake of penance, often remain for years in one position, and whose joints are said to become frequently ankylosed in such an attitude. In such cases, there occurs not only muscular contracture, the insertion points remaining permanently approximated, but also proliferation of the vascular synovial processes, and characteristic changes of the cartilage, especially at the points where the articular surfaces no longer touch; and here some part is also played by the first motions made after prolonged rest, which then act as an inflammatory irritation (Volkmann[4]).

The great majority of cases originate in articular affections. Indeed most of the deeper articular processes lead to contractures or ankylosis of the joint. The process is usually this—after destruction or perforation of the articular cartilage, the granulations on the surface of the two extremities become adherent, and during recovery firm fibrous adhesions are gradually formed, which later may become ossified. Or else, as the result of inflammatory irritation, spicula of bone,

stalactite-like osseous proliferations develop and interfere [illegible] with motion, or lead to complete adhesion (Fig. 156). The [illegible] most various articular affections, especially of tuberculous, rheu[illegible]umatic, but also of gouty, gonorrheal, syphilitic, puerperal, ne[illegible]eurotic, etc., nature, may thus lead to ankylosis; and many [illegible]y of these articular affections have a particularly marked tende[illegible]ency to cause multiple ankyloses, especially the gonorrheal [illegible] and rheumatic. Inflammatory processes, traumata, etc., in [illegible] the neighborhood of the joint, may also give rise to ankylo[illegible]sis. Phlegmons, phlegmonous erysipelas which causes extens[illegible]ive

Fig. 156.—Ankylosis of the Knee with Subluxation (Seen from Behind).

Fig. 157.—Fibrous Ankylosis of the Knee with Tuberculous Remnant in the Condyle of the Femur. (Onix.)

necrosis of cellular tissue, burns, etc., followed by considerable cicatricial contraction, cicatricial contractures, fractures, etc., near the joint are of particular importance as causal factors. Morbid processes in the muscles, *e.g.*, so-called *myositis ossificans*, may cause extensive ankyloses.

In the majority of cases these etiological factors are combined, *e.g.*, in the finger contracture occurring frequently in consequence of gangrenous forms of panaritium, the loss of the flexor tendon and cicatricial contractions and adhesions around the joint playing a part in the abnormal position.

The pathological anatomy of ankyloses allows the differentiation into ankylosis spuria (fibrosa, cartilaginea, ossea),

also into synostosis and ankylosis extracapsularis (bony-bridge ankylosis). Usually the real osseous adhesion is preceded by a stage of fibrous or cartilaginous ankylosis, and the pathological conditions found vary according to the stage or duration of the affection.

Chronic ankyloses may lead to adhesions so uniformly firm that it is hardly possible to recognize any demarcation of the bones, either on the external surface or in the internal structure; frequently, where the inflammatory process is still present, the synostotic bones are covered with numerous stalactitic fine bony needles, etc., which are inclosed in a more or less firm cicatricial mass (Fig. 156).

An important fact is, that in ankylosed joints morbid deposits are often included, *e.g.*, tuberculous foci, which in case of trauma, etc., may cause a relapse or a fresh eruption of the disease. As a rule, the form of the joint is much altered, and cases are rare in which the affected bones appear only as if connected by bony substance, and otherwise unchanged.

The muscles which are thrown out of action by the ankylosis are usually more or less atrophic, in chronic total ankyloses they are often fatty degenerated throughout; the growth of the affected limb is more or less markedly stunted, according as the morbid process has occurred early in life, and has implicated the epiphyses or not.

The symptoms of ankylosis consist in the greater or less loss of mobility, occasional major or minor deformity, and further in secondary or compensatory disturbances.

A positive diagnosis of the condition can only be made in narcosis, since involuntary contractions of the muscles, etc., may simulate contracture or ankylosis. Anæsthesia will also permit the recognition of the kind of ankylosis; for instance, if in case of bony ankylosis one hand is placed above, another beneath the affected part, a peculiar sensation of rigidity is imparted when passive movements are attempted. Immobility alone is by no means a sign of bony ankylosis. In examining without anæsthesia, it is to be noted that gentle manipulations (the patient's attention being diverted) facilitate the diagnosis, since forcible movements readily cause reflex contractures.

Sanson[5] relates a case in which a hospital physician had diagnosticated ankylosis of the hip of a child; but another

physician present, by directing the child's attention to some other subject, easily demonstrated the mobility of the joint.

At the present time, the prognosis of ankyloses and contractures is generally favorable, for it is possible in most cases to cure the condition by apparatus, massage, manipulations, etc., and if necessary by operative methods (which have become justified only since the advent of antisepsis), or at least to give the limb a position most useful to its function.

In the way of treatment, mention should first be made of prophylaxis, which consists in the correct treatment of the rather frequent joint affections, fractures, etc., that is to say, the diseased joint should always be fixed in its most useful position (*e.g.*, elbow flexed, knee and hip extended). In general, the fixation should not be continued too long, but be supplemented at the proper time by massage, manipulations, frictions, passive and active movements, etc. Where cicatricial contraction is anticipated, this should be counteracted by appropriate position.

The treatment aims at stretching the contracted parts, at making the ankylosed joints movable, or at least as useful as possible functionally.

The milder measures, gradual (elastic) traction, massage, etc., can be successfully employed only when the adhesions are not too firm. The great number of ingenious appliances devised for the treatment of contractures and ankyloses consists usually of two excavated splints for receiving the respective parts of the limb, made adjustable at the desired angle by screws, etc. Where it is necessary to change an angular position into a straight one, the commonest methods are simple extension by weights, according to Volkmann, or elastic traction appliances. Where mobility is aimed at, the splints are made movable on each other by a cord running over a pulley, on a higher level, as in Bonnet's automobile apparatus. Elastic traction may also be used for this purpose by being made to act alternately in the direction of flexion and extension. Reibmayr and others have devised such apparatus. Figs. 158 and 159 show a simple apparatus for restoring mobility to the elbow joint (a hinge joint is inserted at A). Since, however, these methods are slow in action and without effect on the firmer adhesions, it was but natural that efforts were early made to break up the ankylosis forcibly, or to

overcome an abnormal angular position. It is mainly since the time of Louvier, who performed forcible redressement with a machine of his own invention, that we can speak of a separate method of "redressement brusque" or "brisement forcé" (arthroclasm), *i.e.*, a rapid, forced correction of the position —a procedure perfected chiefly by Dieffenbach, Langenbeck, Palasciano, and others. *Brisement forcé*, however (with which, by the way, Louvier did a good deal of mischief, as shown by some autopsies), only found general acceptance after the introduction of anæsthesia. As a rule, the manual power of the surgeon suffices, but the osteoclasts which we have already described (Collin, Robin, Beely, etc.) may likewise be used. The aim is to start the movement in accordance with the normal axis of the joint, so as to avoid infractions or fractures. It is particularly important that the force should not act too far

FIGS. 158 and 159.—Apparatus for Correcting Contracture of the Elbow by Alternate Elastic Traction. (After Collin.)

along the long lever arm of the peripheral portion of the limb, and it is advisable in some cases where great force is to be exercised to cover the limb with a plaster dressing up to the point where mobility is to be established, and by including a long splint in the dressing, to use the latter as the prolongation of the lever arm.

The first attempts at forced movement should always be made in the sense of flexion, only the later ones being toward extension, afterward flexion and extension may be combined.

It was formerly believed that the tense sinews and fasciæ should almost invariably be first divided (Brodhurst, etc.), but this preliminary tenotomy can be avoided as a rule, and where it becomes necessary it is, of course, to be done under antiseptic precautions. If the bone is connected with adherent cicatrices, their subcutaneous detachment may be indicated, so as to avoid rupture of the skin in the redressing; in

the case of cicatricial contractures, division or excision of cicatrices must occasionally be performed.

Brisement forcé is performed in profound narcosis; the limb is properly fixed by the hands of the assistant, the surgeon grasps the peripheral portion with both hands, forcibly flexes and then extends the limb, continuing the alternate attempts at flexion and extension until good mobility in both directions is attained. After this a suitable dressing is of great importance. Sayre recommends bandaging the limb, commencing at the peripheral end, and exerting compression over the joint by sponge (a cotton pad, etc.). The limb is kept elevated and the bandage is changed only after six or seven days. When the adhesions are extensive, a distinct crackling can generally be heard during *brisement forcé*, and all of a sudden the joint gives way; with proper precautions the method is free from any great risk. The method is, of course, out of the question, while inflammation or suppuration is still present. We must remember, above all, the possibility of setting up acute suppuration (Oberst[6]) or the occurrence of general tuberculosis from *brisement forcé* (Szumann[7]), and latterly, indeed, the method has been employed less frequently than it was by Langenbeck.

Even complete bony ankyloses in unfavorable position are of favorable prognosis to-day, for the antiseptic treatment of wounds justifies us in performing various operations on the bones—operative correction. A combined method is that where ankylosed bones, like the patella or the olecranon, are detached with the chisel (Maunder[8]) before performing *brisement forcé* or where the soft parts are first divided (avoiding vessels and nerves). For true ankyloses in unfavorable position the operations to be mainly considered are osteotomy (simple linear, arciform, etc.), osteectomy, more rarely *resection en bloc, i.e.*, removal of the adherent articular surfaces.

In case of angular ankylosis of the knee, Bauer used to resort to amputation; but, to-day, such radical means will be called for rarely, except in case of ankylosis of the fingers which interferes with working or where the fingers are no longer functionally useful owing to considerable degeneration, stunted growth, etc.

To pass, now, to the consideration of the contractures and of ankylosis of the special joints, the larger articulations of

the trunk and those of the hand are practically of the greatest interest.

Contractures or ankyloses of the hip-joint are probably very rarely of a cicatricial nature, and are more frequently due to peri-articular inflammations, such as that following on psoas abscesses, etc. The great majority of cases of true ankyloses are arthrogenous, *i.e.*, arise in connection with coxitis, and result in flexion, adduction, and inward rotation of the limb.

The characteristic position of the leg, which is usually asso-

FIGS. 160 and 161.—Deformity after Coxitis. The Affected Extremity is Stunted in Growth and Nutrition.

ciated with muscular atrophy and shortening, causes essential disturbances in walking, such as limping, and the greater the flexion the more pronounced will be the secondary lumbar lordosis and the depression of the pelvis, the result of efforts to use the leg in walking. Secondary kyphotic compensatory curvatures and static skoliosis may be ultimate sequelæ; the disturbances are of course greater in bilateral ankylosis.[9]

The disturbances are the greatest in the rarer forms of ankylosis of the hip in flexion and abduction, where even crutches cannot be used. The most aggravated of all is bilateral ankylosis in abduction, of which I have seen several

examples (Fig. 162), where the patients are forced to move on all fours or to jump like frogs.[10]

Such deplorable deformities occur especially after severe articular rheumatism, and they may not be recognized for a long while, owing to the fact that the patient is bedridden.

Prophylaxis of contractures of the hips, etc., consists in the correct treatment of hip-joint disease by extension and fixation (Thomas, Taylor, Bryant, Sayre's splints, etc.), and in appropriate resort to passive movements after acute rheumatism, etc.

In examining for contracture of the hip, care must be taken that the pelvis is straight, and that the lumbar spine rests on the couch, for even in flexion-contracture of the hip the thigh

Fig. 162.—Bilateral Contracture in Abduction following on Rheumatism, etc.

Fig. 163.—Flexion Contracture of the Left Hip-joint.

Fig. 164—Apparent Equalization by Lordosis of the Lumbar Spine.

can be pressed down on the bed (Fig 164), since the lumbar spine assumes a compensatory curvature, and the hand may be passed under the sacrum of the patient. If the lordosis is straightened so that the entire spine rests on the couch, the thigh in flexion-contracture points upward.

In order to test the degree of mobility, an assistant must firmly fix the pelvis of the anæsthetized patient, while the surgeon manipulates the leg. In contractures permitting some motion, the ordinary extension dressings may suffice, provided the pelvis is properly fixed.

Lorinser[11] deems it better to fasten the thigh and to make the two tuberosities of the ischium points of fixation, gradually raising them by a screw, while the weight of the trunk effects a slow depression of the lumbar spine. (See Fig. 165, in which *b* represents the pelvic bolster which is raised by the

screw S, between the two segments of the mattress; while Fig. 166 shows conjoined extension of the leg by the screw S.)

Fig. 165.—Lorinser's Apparatus for Contracture of the Hip.

The various forms of extension beds (Heine, H. Bigg, etc.), may also prove useful in the graver cases.

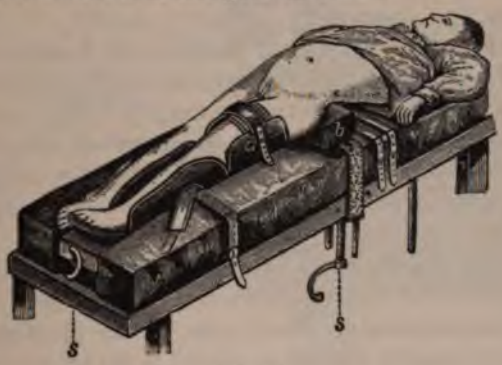


Fig. 166.

A number of special apparatus have also been devised for contracture of the hip. One of the simplest methods, which

Fig. 167.—Stillman's Sector Splint.

may be conjoined with extension, is that by Stillman's sector splint (Fig. 167), which is applied in a plaster dressing, sur-

rounding the pelvis and thigh, and it permits changes of position only in the sagittal plane. Another apparatus of Stillman's aims at mobility in all the three planes through a universal joint.

Of other apparatus for ambulatory treatment in redressible contractures of the hip, mention may be made of that of H. Bigg, the mechanism of which is based on an S-shaped spring, or of another devised by the same gentleman, in which elastic traction is applied from behind to the thigh splint by a lever arm, the endeavor being to extend the thigh, while the pelvis and spine are supported by a belt and an axillary crutch, respectively. Berthet has devised an apparatus in which two angular lever arms (one springing from the pelvic belt, another from the thigh splint) are approximated by elastic traction.

Other apparatus (H. Bigg, Mathieu, etc.) utilize an endless screw at the hip-joint for overcoming the contracture.

In the extension apparatus devised by Ulrich and Mittler[12] motion is also effected by means of an endless screw, while fixation is secured by an iron band surrounding the pelvis, and by pads bearing on the symphysis and on the iliac spine. Perineal belts prevent displacement.

Where the object is not merely correction of the position, but mobilization of the hip-joint, use may be made of an apparatus recommended by Brodhurst[13] after H. Bigg, in which the pelvis is properly fixed, and a cord is attached to the lower extremity and carried over a pulley in the ceiling, so that the patient may practise passive flexion of the hip by traction on the cord, while the weight of the limb brings it back into extension.

Other ingenious appliances have been devised by Bonnet for passive movements, especially for rotation of the hip.

For the rare cases of adduction-contracture, successful use may be made of H. Bigg's instrument, which consists of two splints, connected by a hinge, passing along the inner surface of the thigh, with leather caps for the region of the knee. The splints may be set at any desired angle by means of screws and extension rods, while the point of the instrument rests below the perineum. A similar apparatus has been devised by Busch. The simplest instrument for keeping the knees apart is the spiral spring set between pads.

In cases where bony adhesion has not yet occurred, more rapid results may be reached with the method introduced chiefly by Berend, Dieffenbach, and Langenbeck, viz., forced redressement, a method which, of course, is contra-indicated when the disease has not yet run its course, or fistulæ, etc., are present. Usually we hereby only secure improved position, and even this by several repeated attempts, rather than at a single sitting.

Ordinarily manual force will suffice, but we must beware of causing a fracture of the diaphysis of the femur—an accident which has occasionally occurred. Fracture of the neck of the femur (as has been observed by Rossander, Tillaux, and Volk-

Fig. 168.—Terrillon's Apparatus for Fixation of the Pelvis.

mann [14]) is no great disadvantage, since the thigh may afterward be extended.

Special fixation apparatus has been recommended for *brisement forcé* of the hip. Bauer's apparatus consists of a wooden block, padded with leather, which is closely fitted and strapped to the posterior surface of the pelvis. The apparatus of Collin-Terrillon is easily understood from Fig. 168. For instrumental *brisement forcé* the apparatus of Robin, Collin, and others, previously described, may be used.

When the limb has been straightened, much depends, of course, on the correct maintenance of the improved position, and to this end traction dressings, Bonnet's wire hose, etc., must be used for several weeks at least.

In a large number of cases, especially of osseous adhesion, operative methods must be considered. Many operators favor tenotomy followed by *brisement forcé* (Sayre).

For bony ankylosis of the hip in angular position, operation under antiseptic precautions is certainly a safer method than forcible manual or instrumental osteoclasis.

Rhea Barton, in 1826, was the first to divide the femur between the trochanters with the fret-saw, in bony ankylosis of the hip, and since then oteotomy had been further developed. Langenbeck first perforated with an auger, and then divided the bone from this point as far as the cortical layer, when the fracture was completed. Adams (1869) performed subcutaneous osteotomy of the neck of the femur with the saw, but with careful antisepsis it is certainly preferable (MacEwen) to make the wound large enough for the introduction of the finger, and then to divide the neck of the femur with the chisel, when the thigh can be easily straightened and healing ensues under the first dressing. Brodhurst pointed out that it was of great importance to effect the division as near as possible to the centre of motion.

FIG. 169.—*a*, Osteotomy of the Neck of the Femur; *b*, Intertrochanteric Osteotomy; *c*, Subtrochanteric Osteotomy.

In many cases it is better, owing to destruction of the head of the femur, or to osteophytic proliferation around the neck, etc., to make the division below the trochanter according to Gant[15] and to Maunder. Subtrochanteric osteotomy has been chiefly developed by Volkmann,[16] so that at present it represents the most frequently employed procedure, and is especially adapted to serious adduction-contractures in which the head of the femur is outside the acetabulum and *brisement forcé* is therefore inapplicable.

The division is effected with the chisel about opposite the small trochanter (Volkmann), after detachment of the periosteum; a wedge-shaped piece is excised, whose base, corresponding to the conjoined position of flexion and adduction, is directed backward and outward; the bone is not cut through entirely, but the wall at the minor trochanter is fractured, as the last step.

Holmer and others carry the osteotomy somewhat deeper

than Volkmann. What serious deformities may be rectified by these operations is shown among others by G. Ledderhose's[17] case of bilateral subtrochanteric osteotomy for ankylosis of both hips, in extremely adducted and inward rotated position, in a man aged twenty, represented in Figs. 170 a and b before and after operation respectively. Next in order are the wedge-shaped osteotomies for ankylosis of the hip, which were also largely practised by Volkmann, K. Rodgers, and Sayre.

Although after various osteotomies of the neck of the femur, mobility has been attained (Brodhurst, Adams), the

Fig. 170 a.—Ankylosis of both Hip-joints in Curved Position.

Fig. 170 b.—The Same after Operation (Ledderhose).

majority of operations aimed only at improvement of position; and in order to secure mobility after osteotomy, Sayre[18] has only excised a semilunar piece from the neck of the femur, the concavity being directed downward, and in such cases he has attained his object of imitating the natural joint and of making it movable.

Where we have reason to believe that morbid residues are present in the hip-joint, *i.e.*, where the inflammatory process has not run its course, it would appear preferable to remove the remains of the head and neck of the femur, by making Langenbeck's usual posterior longitudinal incision and separating the great trochanter with a chisel. After that the acetabulum should always be exposed and inspected (Kölliker[19]). In rare cases, *e.g.*, in strongly abducted position, an

anterior longitudinal incision is more suitable (as performed by Billroth and others). The after-treatment of orthopedic resection of the hip is the usual one, extension by weights for from three to six weeks, after which the patients practise walking with Volkmann's stool (*Gehbänkchen*), while extension is continued during the night for a longer time (Kölliker), and then follow active and passive gymnastics by methodical movements, etc. The cure of angular ankyloses, together with retention of mobility of the thigh, has thus been secured after resection with the chisel (Gritti).

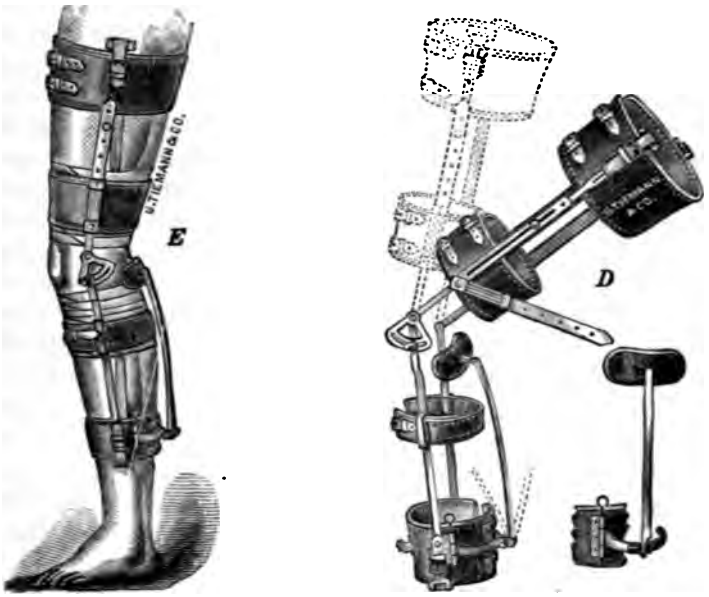
Rosmanit[20] has calculated the following mortality: after 35 osteotomies at the neck of the femur, 11.43%; after 34 subtrochanteric osteotomies, 8.82%; and after 28 wedge-shaped excisions below the trochanter, 7.14%. Hence there is no material difference in the statistics and the same may be said of the functional results; resection, being a more formidable operation, has a greater mortality, 30% (Rosmanit), which will, however, be reduced by antisepsis.

Resection is absolutely indicated only in bilateral ankylosis, since two stiff legs cannot be used for walking, especially since not even crutches can be employed in the abducted position. On one side simple osteotomy with correction of the false position may be done; on the other side, resection must be performed. Such double operations have been done by v. Bruns, Volkmann,[21] Billroth, Mordhorst, and others. Studensky[22] performed double resection and he obtained mobility on both sides in the new-formed joints, although, of course, the length of the legs became unequal, owing to the upper end of the femur on the right side gradually gliding up on the venter of the ilium.

The most frequent and important contractures are those of the knee-joint, which too often result from the faulty treatment of articular inflammation; according to their severity they represent a permanent grave injury which can be avoided by appropriate prophylactic treatment.

While in Germany retentive dressings in extended position stand foremost in the treatment of the usual fungous (tubercular) form of inflammation of the knee-joint, the only mistake being that these dressings are removed too early and contractures develop subsequently, in England and America special apparatus is in favor, which permits extension and

fixation in the desired position and can be worn through all the stages of the articular inflammation. Of these, mention will be made only of the apparatus shown in Figs. 171 and 172, after Stillman. In addition to the sector joint, it carries a pad which crowds the head of the tibia forward, thus counteracting the characteristic subluxation of the tibia. Ankyloses of the knee-joint in extended position will seldom come under treatment. Angular contracture or ankylosis of the knee, being a very frequent deformity, probably usually requires



FIGS. 171 and 172.—Apparatus for Inflammation of the Knee-joint. (After Chas. Stillman.)

surgical treatment, although, under the methods of treatment now generally employed in chronic inflammations of the knee-joint, it is exceptional that we see cripples who ride, so to speak, with the thigh on a wooden leg, the angular stiff knee projecting in front.

For straightening angular contractures of the knee and fibrous ankyloses, use is made in mild cases of gradual extension (with oblique foot-board, extension by weights downward at the knee, elastic traction, etc.); in most cases we must rest content with stretching the leg and thus enabling the patient to walk.

Wiskemann[23] effects the stretching by fastening to the extensor side of the thigh a long splint which is nailed to an upright board at the lower end of the bed, whereby he attains a sort of suspension of the leg, and (with appropriate fixation of the pelvis) the leg is gradually approximated to the splint, or stretched by elastic bandages. If the pain is great, the elastic traction may be intermittent.

Fig. 173.—Angular Ankylosis of the Knee. (After Lorinser.)

Elastic traction may also be applied by fastening to two articulating splints elastic cords, running over pulleys affixed higher up, as, for instance, in the apparatus devised by Schepelern.

Another very suitable apparatus is that of Lorinser[24] (Fig. 174), which consists essentially of three small boards adjustable to each other (2, 3, 5); of these the leg board, which is joined to the thigh board by a hinge, carries at its lower end a movable nut (6), through which passes the horizontal screw of the base board, which is turned with a key (Fig. 174). The apparatus of Tamplin and Duval belong in the same category.

Bonnet's well-known apparatus is very similar. It consists of two hollow splints joined by a hinge in the region of the knee, and a base board. The foot is surrounded by a sort of leather gaiter, to which is fastened an extension cord, to be tightened by a spindle. Two small pulleys at the foot end of

Fig. 174.—Knee Extension Apparatus. (After Lorinser.)

the leg splint prevent friction as much as possible. Volkmann recommends the apparatus in the form of two well-fitting tin splints joined by hinges and fastened to a base board, using weights as the extending force. For the gradual ambulatory extension of contracted knee-joints a large number of apparatus has been devised. Among the simplest are the retentive

dressings which are applied after the best feasible correction of the position (under anæsthesia) has been attained and are renewed at suitable intervals after further correction.

Since it is desirable to keep the joint under observation during this time, frequent use has been made particularly of interrupted retentive dressings, with articulated splints adjustable at the side.

Fig. 175.—Sector Splint.

A very suitable form is the sector splint, such as that recommended by Braatz,[25] in which the leg splint can be set at any desired angle in a sector groove of the thigh splint, so that the position can be improved manually every few days, and be retained by a thumb screw; or the form advocated by Stillman[26] under the name of "sector joint brackets and splints" which can be set at any angle without being removed, permits extension and occasionally motion, and is usually fastened by means of a plaster-of-Paris or adhesive plaster dressing.

These sector splints are made of steel with a flexible, perforated copper plate for encasing the limb, a sector (Fig. 175) being interposed at the joint. A slit in the sector permits motion to any desired angle, where the thumb screw will retain it.

Fig. 176.—Stillman's Sector Splint.

A large number of the apparatuses devised for angular contracture of the knee, are based on the application to the side of the angle of an extensible screw-worm, by which the angular position can be gradually diminished (Kolbe, Pancoast, Roberts,[27] Salt, Burow, Nyrop).

One of the best known of these is Eulenburg's extension apparatus, consisting of two articulating capsules, in which the leg and thigh are fastened by straps; by means of endless screws, a spindle and a winch, they may be moved on each other as described.

The apparatus permits the patient himself to make exten-

sion and flexion movements, and is distinguished by facility of application, uniformity and, as desired, either slowness or rapidity of effect.

According to Bidder,[28] the apparatus has the advantage that (since buckles and straps are not used) any circular constriction is avoided. Two semicircular grooves for the calf and anterior surface of the thigh form the main points of support, to which are applied the curved steel splints which articulate in a joint with endless screw lying anterior to the axis of rotation of the knee. The "saddle-groove" fitted to the posterior surface of the thigh, which adapts itself to the movements and is to be fastened with straps, prevents separation of the upper portion of the thigh splint when the screw is tightened.

Ridlon [29] in his apparatus employs a hinge-joint adjustable

FIG. 177.—Dieffenbach's Apparatus for Extension of the Knee.

by an endless screw. Thigh and leg are bandaged to the dorsal padded steel hollow splints.

Dieffenbach's contrivance, which is warmly recommended by V. v. Bruns, consists of grooved thigh and leg splints with two lateral splints (connected by cross pieces) articulating at the knee. The outer thigh splint ends in a semicircular plate toothed at its convex margin, the cogs being geared into the grooves of an endless screw at the upper end of the leg splint, so that the leg piece (which, like the thigh piece, is fastened with several straps) can be set by means of a key at any desired angle to the other. A square knee cap, applied in front over the patella and the condyles of the femur and buttoned to the splints, serves for further fixation, and prevents forward deviation of the knee.

The apparatus devised by Langgaard [30] (likewise provided with bilateral splints, laced thigh and leg pieces, and anterior

knee cap) is moved by an endless screw on each side of the upper end of the leg splint, where it engages in a toothed wheel at the lower end of the thigh splint. In the form de-

FIG. 178.—Stromeyer's Apparatus for Extension of the Knee.

FIG. 179.—Erichsen's Apparatus.

vised by Stromeyer (Fig. 178), the toothed wheel is at the upper end of the leg splint, and the endless screw at the lower end of the thigh splint.

Of great value for slighter cases is the ingenious apparatus of Erichsen, or that of Heather Bigg, which is based on the action of two S-springs acting in opposite directions and, by

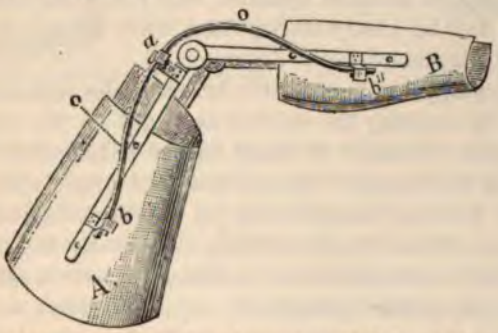


FIG. 180.—Oehler's Knee Apparatus with Spring Action.

means of two leather casings, it draws the leg forward, the femur backward, thus counteracting flexion and subluxation.

Other apparatus similarly employ spring power, as that constructed by Oehler[31] (Fig. 180), in which the laced leather

pieces are attached to two lateral articulated splints, each of which carries three small forks (one median, open in front, close to the joint; one above and one below, open behind). Into these forks springs are inserted (from one to six on each side, according to requirements) which give the leg a gentle, steady impulse toward extension.

Fig. 181.—Apparatus for Slight Angular Contracture of the Knee. (After Nyrop.)

Uniform, powerful traction can also be effected by the employment of rubber, which acts even more vigorously. Blanc,[32] of Lyons, has devised several appliances, all on the same principle, viz., jointed splints for thigh and leg (fastened by retention dressings or straps) are provided with anterior iron lever arms, which are approximated by rubber rings, thus aiming at the obliteration of the angle. H. Bigg applies to the thigh- and leg-pieces anterior iron hooks united by elastic traction; so does Nyrop (Fig. 181); two leg splints, hinged at the knee, united above by a pelvic strap, *e*, carry below a joint for the ankle, and a strap, *f*, for fixing the foot; above and below the knee are projecting lever arms for applying elastic traction, *b;* a knee cap, *c*, presses against the prominent knee. Such apparatus can be easily improvised with strong wire and an interrupted plaster-of-Paris dressing.

Reibmayr applies the elastic traction for extension of the knee-joint, by making the rubber cord act on the lower end of two iron rods fastened at their upper extremities to a band surrounding the femur. Quaas' mode of application is shown in Fig. 182; the leg being drawn by elastic traction toward a prolongation of the thigh splints. In many cases, after removal of the contracture, it is necessary to wear for some time an appropriate protector, *e.g.*, like that of Lorinser shown in Fig. 183, in which 1 represents the lateral steel splint; 2, the clasp for the thigh; 3, that for the leg; 4, the thigh band; 5, the knee band; 6, the leg band. In many cases of contracture and fibrous ankylosis, in which the presence of residuary morbid foci may be excluded, *brisement forcé* succeeded by fixation in improved position, may be expected to

yield the most rapid results; but it is important to avoid the danger of infraction of the tibia, in other words, the long lever arm (the leg) must not be made to bear too great a strain.

Redressement forcé at the knee is performed in the following manner:

The patient lies on the abdomen, the anterior surface of the thigh resting on the table so that the lower end of the femur occupies the edge of the table, and the flexed leg projects free into the air; the latter is grasped by the right hand of the surgeon immediately below the popliteal space, and pressed

FIG. 182.—Quaas' Apparatus for Extension of Contracture of the Knee.

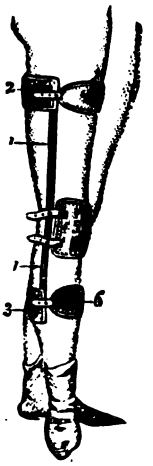


FIG. 183.—Apparatus for Fixation of the Knee. (After Lorinser.)

forward, while the left hand bears down on the thigh. In this way we dispense with the long leverage of the leg, but can easily augment the force by throwing the weight of the trunk on the hand, until the leg yields to the pressure and the extension can be completed, when it is fixed in a plaster-of-Paris dressing or secured by an appropriate protective apparatus (Fig. 183).

In angular osseous ankyloses or those in which the morbid process has not quite run its course, operative measures may be indicated.

Where the patella alone is adherent, it may be sufficient to free it, either according to Hüter with a simple wedge of wood

without injuring the skin, subcutaneously as it were; or else, according to Maunder,[83] with a tenotome inserted at the edge of the patella.

In bony angular anykloses, osteoclasis of the lower portion of the femur has been repeatedly performed (Ollier, Perrusset). Pousson collected fourteen cases. Surgical methods will, however, still be required for a portion of the cases. The first to be considered is linear or arciform (Rosmanit) osteotomy of the tibia or femur or both for acute-angled ankyloses, where mor-

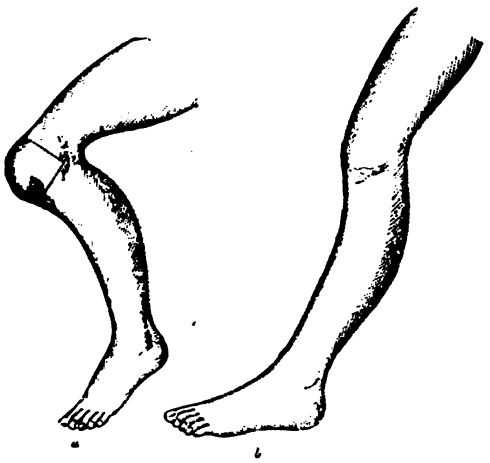


FIG. 184.—Wedge-shaped Excision in Right-angled Ankylosis in the Knee; *a*, before; *b*, after Operation.

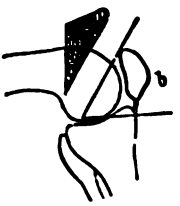


FIG. 185.—Schematic Representation of Excisions in Angular Ankylosis of the Knee.

bid foci are no longer present, and the process has terminated in bony ankylosis.

Volkmann performed the first antiseptic osteotomy of the femur for ankylosis of the knee in 1874, then followed Billroth, MacEwen, etc.

The first rank is to be accorded to wedge-shaped osteotomy, as performed originally by Rhea Barton, that is to say, it is necessary to remove a wedge of bone from the lower end of the femur, which usually projects forward, so as to effect straightening; the shaded part *a* in Fig. 185 represents this method schematically.

Next to be considered is *resection en bloc* (Gurdon-Buck), *i.e.*, the resection of the bony adherent joint (*b*, Fig. 185) for cases in which prolongation of the affected bone is associated

with angular fixation. The size of the bony wedges which must here be occasionally removed appears from Figs. 184 *a* and *b*, which represent the extremity of a young man of twenty, before and after *resection en bloc*.[34]

The gait of the patient in this case was all the more objectionable because, besides the right-angled complete bony ankylosis, the affected femur had elongated in consequence of the long-standing articular disease; the function of the straightened leg has become quite satisfactory.

Much more frequent are the orthopedic resections of the knee-joint in angular ankylosis with incomplete bony adhesion which has not quite run its course; resections which, in children, should be performed as conservatively as possible. The operation is best begun with a curved incision below the patella; the condyles of the femur are first removed with the curved saw, after a flap containing the patella has been turned upward. Frequently it becomes necessary, in order to avoid a sharp edge, to remove an additional piece of bone obliquely upward from the posterior portion of the sawn surface (Kölliker); if the leg can then be easily straightened, the tibia must be freshened as superficially as possible, in order to attain bony ankylosis. If the patella lies well upon this, it is freshened and may contribute to the subsequent firmness of the joint; but if it is diseased or fits ill to the tibia and femur, it should be removed.

Fig. 186.—Supporting Apparatus for Angular Contracture of the Knee.

The bone and the ligamentum patellæ may also be sutured, as well as the capsule; then follow drainage, closure, and aseptic permanent dressing.

Owing to the good results from such operations and their safety, it will be exceptional that we will be compelled to order apparatus for patients with angular ankylosis and defective gait, such as the various appliances from the simple wooden leg with saddle to the more complicated apparatus, which answers no other purpose than to permit the patient to walk at least tolerably (Fig. 186).

The contractures of the ankle-joint will be discussed in the

following chapter on talipes. Complete ankylosis at the ankle-joint will furnish ground for operative interference only when it has occurred in a direction which disturbs the function, *e.g.*, pronounced equinus or calcaneus position. Osteotomy and wedge-shaped excisions are here also in place. For bony ankylosis at the tibio-tarsal joint with pes equinus, Berend [35] and Billroth performed wedge shaped excision from the tibia—a procedure which had been recommended by Velpeau.

FIG. 187.—Reibmayr's Apparatus for Contractures of the Shoulder-joint.

The important ankyloses of the maxillary joint do not belong in orthopedics; concerning them, the reader is referred to the recent contributions of König, Ranke,[36] and Zipfel.[37]

Contractures and ankyloses at the shoulder-joint may remain as sequelæ of various forms of articular inflammation, disease of neighboring structures, etc. Here it is advisable to employ prophylactic fixation in different positions, and early manipulation and massage. Appropriate treatment is of especial importance in children, to avoid the occurrence of disturbances of growth in the affected region.

Reibmayr has devised an apparatus for the elastic stretch-

ing of ankyloses and contractures of the shoulder-joint which is shown in Fig. 187. The rod *b* is adjustable in three directions corresponding to the free excursions of the joint; *g* is the elastic strap which effects movement at the peripheral end, while counter-pressure is represented by the pad which is also adjustable at the main rod *a*.

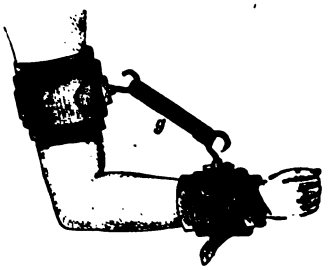


Fig. 188.—Flexion of the Elbow-joint.

In severe cases, *brisement* under anæsthesia and, where the muscles are in good condition, even resection may be requisite.

Cicatricial contractures (especially after scalds) at the elbow require appropriate extension dressings, and occasionally operative interference (division of the cicatrix, plastic operations) which cannot be discussed in this place; even myogenous contractures, though rare, have been observed. At the elbow-joint, however, the arthrogenous contractures and ankyloses are by far the most important, and most frequently require special orthopedic treatment. The degree of contracture or ankylosis is easily recognized under anesthesia. The possibility of increasing the flexion differentiates contractures from ankyloses even without narcosis.

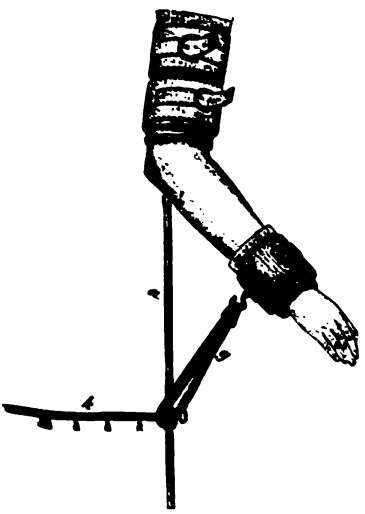


Fig. 189.—Extension of the Elbow-joint (Reibmayr).

In all cases of trauma, or diseases of the elbow-joint, passive movements should not be too long delayed. Where the latter alone are insufficient, Bonnet's apparatus for the mobilization of the elbow is a very suitable instrument for gymnastic manipulations and exercises.

Lücke's [38] apparatus with elastic traction (originally intended for use after resection of the elbow) is also of value, as are those of Reibmayr (Fig. 188) and Collin (Fig. 158), by means of which, according to requirement, flexed or extended position may be aimed at or interchanged; similar apparatus are those of Blanc and others.

Berthet effects flexion of the elbow-joint contrac
extension by affixing to fore-arm and upper arm, res
two lateral splints by means of circular clasps; the
behind more than a hand's breadth beyond the elbo
being applied at the joint and the ends being approxi
a rubber ring.

In order to counteract flexion-contracture of the e
to enable the patient himself to make passive motio
tension, v. Bruns[40] among others has devised a sim
ratus which consist essentially of hollow tin splint
hand, fore-arm, and for the upper arm, respectively,
a hinge at the elbow and fastened to the extremity
ages or clasps. At the lower side of the upper-arn
extends an iron rod with a pulley at its anterior e
projects beyond the groove for the fore-arm and whi
easily attached to a table by an angular hook wit
screw. A cord passing from the lower end of the
splint over the pulley of the iron rod, manipulated
hand of the sound side, effects extension, while flexio
formed by the flexor muscles or the elastic retraction.

A similar contrivance has been devised by J. Hop

In a number of apparatuses for contracture of t
(Kolbe,[41] Stromeyer) the position can be altered by
thread applied on the flexor side, between the upper-
fore-arm splints; in others, like the apparatus of Par
Manget, the screw, by means of which the gutters j
two articulating splints can be given any desired po

tion to each other. Where the adhesions are very extensive, *brisement forcé*, followed by passive movements, will also yield the most rapid results at the elbow; where the contracture shows a tendency to recur, this can be counteracted by suitable splints with elastic traction.

Elbow-joints ankylosed in good position, *i.e.*, at about a right angle, will rarely call for operative interference; but in firm ankylosis in extended position resection is the best procedure for obtaining a movable joint; in bony ankylosis a wedge-shaped excision from the synostotic adherent joint surfaces will be requisite. Defontaine [43] obtained good results in one case by a trochleiform osteotomy.

Sayre performs the resection by making a simple straight incision over the joint, exposing the bone by drawing the soft parts aside, and, in order to reach the point of attachment of the triceps, separating first the end of the olecranon, then sawing through humerus, radius and ulna; then the extremity is placed in a fixation apparatus and passive movements are soon begun.

At the wrist-joint, as at the foot, various kinds of contractures occur which are termed club-hand (*main bot*, *Klumphand*); but while the lateral abduction and adduction contracture and the rotatory pronation and supination contractures are of but little practical importance, we are most interested in contractures of flexion and extension (dorsal and palmar club-hand).

Contractures at the hand are rarely congenital; in such an event they are usually combined with other abnormities (defective development of the bones of the fore-arm, webbed fingers, etc.). Congenital club-hand is ordinarily a contracture in the palmar direction, *i.e.*, an approximation of the volar surface to the flexor side of the fore-arm, at times with more or less pronounced lateral deviation.

The acquired contractures of the hand are much more frequent. They may result from injuries, especially burns, as cicatricial contractures which often give rise to the greatest deformities of the hand, *e.g.*, with fingers completely adherent to the dorsal surface of the fore-arm and fixed by cicatrices; or else, phlegmons, injuries to tendons may cause such deformities; or again they may occur as arthrogenous contractures in consequence of disease of the wrist-joint. The most fre-

quent of all the acquired contractures of the hand are probably the paralytic forms, *i.e.*, those occurring as sequelæ of

FIG. 190.—Congenital Club-hand.

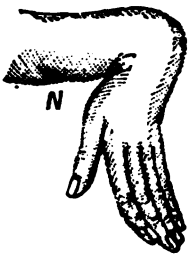


FIG. 191.—Traumatic Club-hand, Cicatrix at N.

FIG. 192.—Pathological (Neurotic) Claw-hand.

infantile paralysis and other diseases of the central nervous system (Fig. 192).

Appropriate prophylactic treatment, fixation in a position opposed to the direction of the contracture, passive movements, and especially the application of elastic traction may here prove of considerable value. Reibmayr[44] among others has devised an ingenious apparatus for effecting alternate ex-

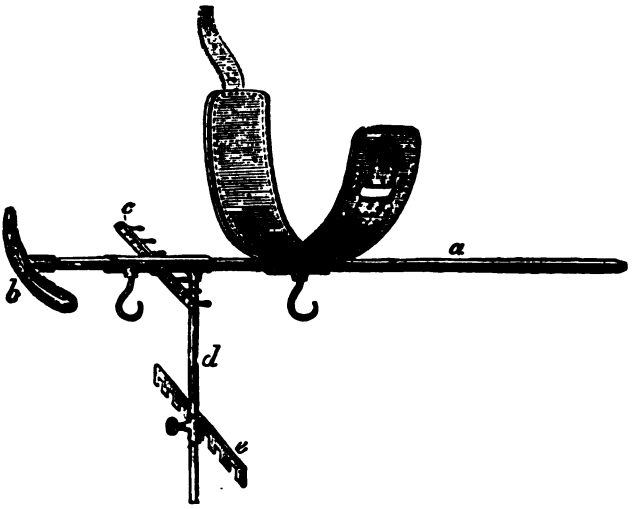


FIG. 193.

tension and flexion of the wrist-joint and the fingers. The apparatus (Fig. 193) consists of a well-padded leather bracelet, a longitudinal rod, *a*, with detachable frame, *b*, a rod, *d*, verti-

cal to *a*, and the two racks for affixing the rubber tubes (the latter the thickness of medium-sized drainage tubes, and tied at the ends into a loop). For the protection of the fingers,

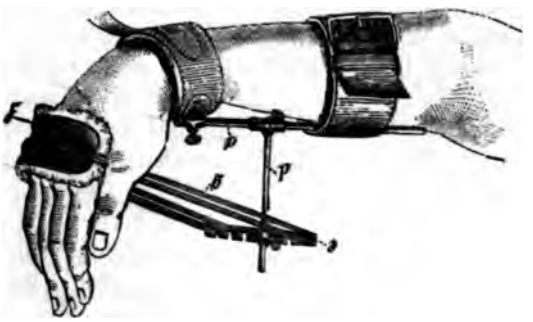


FIG. 194.—Reibmayr's Apparatus for Flexing the Wrist-joint.

i.e., to prevent the rubber tubes from cutting in, Reibmayr uses small tubes of sheet lead.

Figs. 194 and 195 show how the wrist-joint may be alternately extended and flexed. Similar apparatus can be easily improvised with interrupted retentive dressings, articulated splints, and included hooks or rods for the application of the elastic traction.

For flexion contracture of the hand, particularly, a number of appliances have been devised.

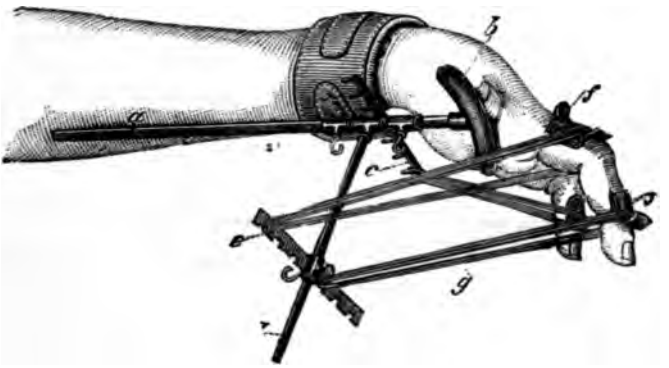


FIG. 195.—Reibmayr's Apparatus for Flexing the Fingers.

Blanc, for example, utilized the elasticity of a rubber ring for approximating the ends of lever splints, and bringing the hand into a straight position.

Gross' apparatus has a dorsal splint fastened to a sheath for the fore-arm which carries at its lower end, over the metacarpal joints, a transverse rod toward which the hand is drawn by an elastic cord, while a dorsal pad exerts pressure on the region of the wrist.

Bruns' apparatus consists of two gutter-like tin splints, joined by a hinge, for fixing the hand and fore-arm, together with an iron rod attached to the dorsal fore-arm splint, which projects beyond the wrist, toward which the hand is drawn by elastic cords.

In other apparatus, like that of Eulenburg and others, endless screws and toothed wheels constitute the adjustable mechanism of the parts which are held together by two lateral articulated splints and straps.

Similar apparatus, arranged inversely, has been constructed for dorsal contracture of the hand; for instance, by v. Bruns (who secured perfect cure by its means in a patient the dorsal surface of whose hand lay on the fore-arm, after he had first tenotomized the extensor tendons); it consists of gutters for the fore-arm, upper arm, and hand, united by hinges. From the volar surface of the hand-splint extends a steel arch which is fastened with a screw to a steel rod, provided with an anterior fissure and extending along the convex side of the fore-arm splint; this renders it possible to maintain the result obtained by manual reposition.

In congenital contractures of the hand, manipulations with fixation in the best possible position will quickly succeed. In the more extensive cicatricial contractures, the division of cicatricial bands, occasionally their extirpation, and transplantation of cutaneous flaps, may be necessary; tenotomy will rarely be required.

A wrist-joint ankylosed in good position does not call for operative interference; on the other hand, ankylosis in aggravated volar flexion may occasionally require resection and straightening, in order to improve the usefulness of the hand.

Finger contractures may also be the result of the most various traumatic or morbid disturbances. Prophylactic treatment will depend on proper management of the causal factors, on passive motion, etc.

Apparatus for finger contracture may be improvised very simply by adding suitable prolongations, such as iron rods

with notches, to a dorsal forearm splint. Against these rods the contracted finger is drawn by elastic cords. A further method consists in placing the hand on a board with processes for the several fingers, padding the contracted finger where it rests on the board, and gradually stretching it by an elastic cord (rubber band) passing over the vertex of the curvature.

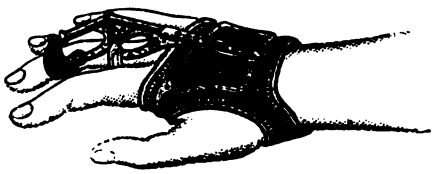


Fig. 196.—Collin's Apparatus for Finger Contracture.

Appliances suitable for the treatment of flexion contracture of the fingers have been devised by Bigg, Goldschmidt and others, in which dorsal splints adapted to the several fingers are movable by endless screws at the level of the articulations; the phalanges are fastened by elastic silk bands to the splints, which are in turn adjustable on a padded plate surrounding the metacarpus; or they may be made movable on the dorsal side of a padded tin splint for the fore-arm and hand (Goldschmidt).

Schönborn's apparatus for extending contracted fingers consists of a deerskin glove, made to button at the ulnar border, which extends above the wrist; into its dorsal part is inserted a steel splint (ten inches long) which, broad at first, narrows at the wrist, again widens at the metacarpus, and at the contracted finger again narrows into a gutter shape, and surrounds two-thirds of the first phalanx. To this gutter a second covered with leather is joined by a hinge, and it receives the volar surface of the second and third phalanges. It carries two wire frames, the peripheral one being one and one half inches high, the central one three-quarters of an inch. To the peripheral frame is fastened an elastic band which runs over a friction roller on the horizontal portion of the central frame, and is buttoned to a knob on the dorsal splint. Thus the traction acting on the finger depends on the thickness of the band and degree of its tension.

Fig. 197.—Nyrop's Apparatus for Flexion-contracture of the Fingers.

Nyrop employs elastic traction in the following manner (Fig. 197): To German silver thimbles, *d*, provided with a slightly curved dorsal process, *f* (to prevent slipping of the

elastic cords), are affixed round elastic co
ened to hooks on a German silver meta
while the elastic extension cord from the th
to a bracelet, *a*, situated higher, but conne
by elastic material, *c*, and padded inside wit
paratus for paralysis of the extensors of th
(Collin, etc.) may also be found of use (Fig.

For finger contractures, Mathieu[45] has
ratus with volar splint and a pad fastened
intended to bear on the vertex of the curv
being graduated by a screw.

In fully developed cicatricial contractu
is advisable, as a rule, to operate: to per
discission, detach the cutaneous cicatrix, di
and unite it longitudinally, making a curv
especially a V-shaped incision which is con

Fig. 198.—Collin's Apparatus for Extensor P

(Busch, etc.). In serious cases of cicatricial
palm, good result may be secured from the
a pediculated skin flap from the wall of the
recommended by Salzer;[46] to take pedic
parts adjoining the hand can hardly be
other parts would be thus endangered.

Partial resection may also have to be
of severe contracture.

Where the finger contracture is complic
the tendon, etc., and the affected stiff fing
work, etc., exarticulation of the finger will
procedure, and if conjoined with resection
ing head of the metacarpal bone, even the
be entirely satisfactory.

In this connection, Dupuytren's finger co
retraction of the palmar fascia (previo
Boyer, Bonnet, and others as *crispatura te*

mentioned. It is a flexion contracture affecting preferably the ring and little finger of older persons, which has a tendency to increase slowly until the affected finger is completely bent into the palm (Fig. 199).

The cause of the affection has been ascribed to repeated traumata, especially in professional workmen (gardeners, carpenters, glaziers, coachmen), and this assumption has something in its favor, particularly in unilateral cases. Thus a switch-tender ascribed the affection to the vibration imparted to the hand on the switch by passing trains; a glazier, to the jarring of the hand from beating the putty into the window-frame; others, to the pressure of the head of the cane. Undoubtedly, acute and chronic traumata, especially in thin

Fig. 199.

Fig. 200.—Dupuytren's Contracture, the Little Finger mainly Affected.

hands, have some influence, although I have observed the affection several times in very fat hands, and it may occur even in people who only handle the pen (Goyrand). Heredity is blamed by some authors (Menjaud,[47] König), others assume a certain connection with rheumatic and gouty affections (Adams, etc.).

The anatomical alterations [48] present in this affection have been studied mainly by Goyrand, Adams, Blum, Kocher, and others; they consist chiefly in a retraction of the palmar fascia with connective-tissue proliferation; trabeculæ springing from the fascia fix the finger in the peculiar position and leave only the third phalanx invariably free; at times there are curved extensions toward the neighboring fingers. The flexor tendon has nothing to do with this retraction, though it is easy to mistake the prominence in the vola formed by the contracted fascia for one due to the tendon.

The symptoms of the affection at first consist merely of slight restriction of extension, especially of the ring or little finger, some tension on the volar side interfering with complete extension; at times rheumatic pains are present in the beginning, or nodal thickenings are noticed in the palm which cause adhesion of the previously freely movable skin. Gradually the finger assumes a contracted position, the flexion affecting the phalango-metacarpal and the first interphalangeal joint, while the second interphalangeal joint is never attacked.

By degrees we may notice in the palm a projection, apparently formed by the tendon, over which the skin extends in an arched fold which is adherent below (Fig. 199). The condition occasionally remains stationary in degree, but usually it is progressive, and leads to the firm flexion of the affected (ulnar) fingers into the palm, thus interfering more or less with function.

The diagnosis is simple: the predominant affection of the ulnar fingers (in very rare cases only is the index finger or thumb mentioned as implicated), the exemption of the second interphalangeal joint, the characteristic alterations in the skin of the palm, these points permit the ready differentiation of the affection from others.

Mechanical treatment, as a rule, cannot accomplish much, except, perhaps, in mild cases at the outset. Pronounced cases require operative measures. Tenotomy here, of course, would be a faulty procedure; division of the tense prolongations of the palmar fascia will remove the deformity in the majority of cases. Subcutaneous discission, especially multiple (Adams), of the trabeculæ has given quite satisfactory results in several cases. Where the retraction is very great and the skin greatly adherent, it would be good practice, in order to avoid laceration of the skin during extension, to select a more thorough procedure which will be free from danger if performed antiseptically (best by Esmarch's bloodless method), viz., either transverse division of the trabeculæ, through a longitudinal incision (Goyrand, Hardie[49]) or the formation of a square flap (Richet).

Busch's method may be most warmly recommended: a triangular flap, its base directed toward the fingers, is dissected off at the point of retraction, and while the finger is

being stretched the tense bands are divided until extension can be completed, when the wound is united longitudinally.

Gersuny and Kocher[50] have operated successfully in several cases by making simple longitudinal incisions and dissecting off the skin from the thick, firm, projecting bands, and then excising the palmar fascia with its processes so far as it is diseased. They therefore recommend the thorough extirpation of the thickened and contracted palmar aponeurosis with its processes, after simple longitudinal incision of the skin, as the correct method for the radical cure of Dupuytren's contracture.

II. Genu Valgum and Varum.

Under the term genu valgum (knock-knee) is understood that deformity where the bones of the legs form with that of the thigh an angle opening outward, or, in other words, where the knee projects inward from a line drawn from the head of the femur to a point midway between the malleoli. Genu valgum is an abduction contracture, as is well shown in Fig. 204.

This deformity is rarely congenital (Dittel, etc.), but, as a rule, forms when the child begins to walk. Formerly genu valgum rachiticum was distinguished from genu valgum staticum or adolescentium (Fig. 202) which first appears in infancy.

Mikulicz first suggested that the latter form was also usually of rachitic origin, and therefore it is preferable to speak of genu valgum rachiticum infantum (Figs. 42, 201), and of genu valgum adolescentium.

The deformity appears with greatest frequency between the ages of two to four, or later between the ages of twelve to eighteen in the male. Bakers, carpenters, waiters, etc., or men who are obliged to stand most of the time, are peculiarly liable to be affected.

Rarer varieties of genu valgum are those which follow on congenital luxation of the patella (Maas, Middeldorpf), that which is of paralytic or traumatic origin (Seydel, Mikulicz) and that which results from disease of the joint, the so-called genu valgum inflammatorium (Volkmann, Maas, and others).

Various degrees of knock-knee have been distinguished. As a rule, the degree may be accurately enough measured by

the eye. For more careful estimation Tillaux, Roberts, Mikulicz and others, have devised special instruments. Ordinarily the tape measure will enable us to note the amount of deviation from the correct line. We thus may obtain the distance *b m* (Fig. 204), from the line *A c* (Fig. 203) which extends from the head of the femur to a point midway between the malleoli. The angle which the leg makes with an ideal line extended from the femur will also serve for measurement. However obtained, the leg must be extended, the patient

FIG. 201.—Genu Valgum Rachiticum Sin.

FIG. 202.—Genu Valgum Adolescentium.

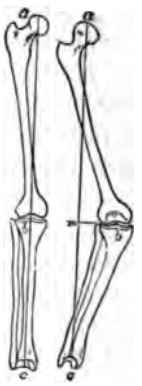
standing or reclining, and the measurement must be made in the anterior plane of the leg.

Formerly the cause of the deformity was sought in the ligaments and in the knee joint. More recent investigations have proved that it resides in the bones themselves.

The ligamentous theory, which was advocated by Stromeyer, Guérin, and Blasius, maintained that first the internal lateral ligament became relaxed, and that next the internal condyle hypertrophied; the muscular theory sought the cause in a retraction of the biceps muscle, in a paralysis of the popliteus muscle, etc. This view was held by Jörg and by Duchenne.

The articular theory of Hüter stated that the cause of genu valgum staticum resided in the form of the condyles, that is to say, it was claimed that the articular facet of the external condyle of the femur was abnormally deepened by pressure of the semilunar cartilage, and that the condyles of the femur and of the tibia remained relatively too low from lack of development.

It is to-day established that the cause of knock-knee resides in changes in the bones. While formerly the partially erroneous view prevailed that the chief alteration was hypertrophy, leading to abnormal height of the internal condyle of the femur or else levelling of the external condyle (usually secondary in nature), the anatomical researches of Mikulicz, Weil and others, have proved that the first changes are to be sought to a less degree in the epiphyseal ends than in the diaphyseal, especially the lower diaphysis of the femur, and further that genu valgum in children depends on the fact that the epiphyses of the femur or of the tibia are set obliquely on the diaphyses as the result of rachitic change in the diaphysis (unequal impregnation with lime).



Figs. 203 and 204.

Neudörfer claims that the most frequent cause of genu valgum is diminished obliquity of the neck of the femur in relation to the shaft. This may occur without rachitic changes and is rarely congenital but almost always acquired.

The post-mortem findings have certainly at times revealed lengthening of the internal condyle of the femur, but this was secondary in nature (Chiari, Guéniot, Lannelongue, and others). An essential alteration in the profile curve has, however, not been determined. Usually more or less marked rachitic changes have been found. The affected bones have been abnormally soft; in half-grown children the epiphyseal ends have been considerably broadened, especially at the expense of the germinative zone. Occasionally the process of growth near the epiphyses has been unequal in degree, and there has existed an abnormal curvature of the entire diaphyseal end. The cartilage of the joint is occasionally found in a state of atrophy on the outside, while internally it is hypertrophied.

The changes are, as a rule, most marked at the end of the femur, rarely at the upper extremity of the tibia. In aggravated instances the patella is occasionally found pushed outward. In old age arthritis deformans may be an accompaniment.

A predisposing cause of genu valgum is abduction and outward rotation following on extension. Abnormally continuous extension position, particularly where the bones are rachitic, leads to unequal pressure and to disturbances in growth. There can be no question but that in tired individuals with weak muscles, prolonged extension of the limbs results in changes in the bones, and the prolonged unequal pressure is followed by unequal growth. Therefore genu valgum adolescentium is also static in source, even though rachitic changes ordinarily are the prime cause.

Mechanical causes may also apparently be influential in the production of knock-knee. Lücke[51] has claimed that the elastic stocking supporters worn by children may, in case the general nutrition is poor, lead to genu valgum.

The symptoms of knock-knee are a greater or less inward position of the knee, an outward projection of the lower limb, and a varying degree of separation of the feet. These phenomena may be uni- or bi-lateral. When the limb is extended the angle formed between the tibia and the femur becomes especially marked. A characteristic point is the fact that on flexion of the limb the deformity disappears. Various explanations of this fact have been offered. Hueter and Girard claim that the reason is the shape of the condyles of the femur; others believe the fact due to compensation by outward rotation of the hips; Mikulicz and Albert[52] are probably right in their assumption that the disappearance results from the obliteration of the anterior plane of the tibia and the femur when the knee joint is flexed.

In marked instances of knock-knee the walk of the individual is more or less altered. In case of unilateral genu valgum the shortening is compensated by sinking of the pelvis. In aggravated bi-lateral instances the X-shaped limbs continually interfere. In consequence the individual keeps the knee flexed and the hips are rotated outward, in order that the knees may as far as possible not strike one another. The subjective symptoms are diminished power of resistance to

labor and fatigue. Where the muscular system is weakened the symptoms are more pronounced, especially if the genu valgum is complicated, as it not infrequently is, by pes valgus. In case of unilateral genu valgum a skoliotic curvature of the spinal column often develops, beginning as a lumbar skoliosis in the direction of the shortened limb.

The symptoms noticeable from the side of the knee, especially in children, before any marked deformity exists, are pain on its inner side, inability to stand for a long time, etc. These symptoms will frequently suggest irritability of the joint due to an inflammatory process.

FIG. 205.—Locomotion in Case of Genu Valgum.

In individuals in whom the musculature is not weak, there frequently develops a compensatory supination, that is to say, the muscles opposed to those which keep the foot abducted and pronated resist and abduct the foot, so that, notwithstanding the oblique direction of the lower limb, the foot is planted firmly on the ground.

Only in case of infantile genu valgum is the deformity likely to become rectified. As a rule, genu valgum, especially in youth, has a progressive tendency up to the twentieth year, when the growth of the bone being completed the deformity remains permanent. Occasionally, however, a similar result occurs earlier, and this is to be explained on the assumption that the yielding bone has consolidated. In general, treatment is most effective the earlier in the disease it is instituted. Knock-knee of long duration calls for most radical methods of treatment. The prognosis is very unfavorable in chronic cases where arthritis deformans has developed, and in such an event the limb may become entirely useless.

The treatment of genu valgum varies greatly according to the degree and the age of the patient. It is symptomatic of progress in our art that an affection which no longer than fifty years ago was considered incurable, aside from its occurrence in young children, to-day may be looked upon as almost uniformly curable by one or another of the methods at our disposal. Infantile genu valgum must be considered separately, seeing that it rarely requires operative measures, but may be cured through resort to orthopedic devices and apparatus.

The treatment of genu valgum must subserve two purposes: It must restore normal function to the affected extremity, and it must fulfil the esthetic indications, that is to say, give the limb the natural appearance. The simple section of the external lateral ligament, of the tendon of the biceps and correction of the curvature in the middle of the lower extremity will not alone suffice (Mikulicz). There are two methods at our disposal: the one is the gradual and the other is the forcible correction of the deformity. The first is especially applicable to the deformity in children, and the aim is secured by apparatus and orthopedic appliances. The second method is preferable in case of adults and particularly in case of dispensary patients, who can neither spare the time required by mechanical treatment, nor afford the expense of apparatus. For this class of patients the operative measures, of which more than a dozen have in modern times been suggested, are suitable.

Fig. 206.—Heine's Conical Cushion.

In case of bilateral genu valgum of slight degree, one of the simplest methods is the use of a cushion (Fig. 206), which is fastened between the knees and then, by elastic traction over the ankle joints, the feet are drawn together. This method may be readily resorted to at night. A further simple method is Langenbeck's, which consists in making traction on the knees outward. This method, however, is open to objection on the score that it weakens the ligaments and it is therefore not used much nowadays.

We may divide the appropriate apparatus into those which the patient may wear and attend to his occupation, and into that which necessitates rest in bed. Of the latter variety the simplest of all is an elastic traction splint (Tuppert, etc.), placed on the outside of the extremity, to which the knee is strapped. In children this method is open to the objection that the splint is apt to slip from outward rotation and flexion of the knee, and therefore quickly becomes useless. It is preferable, hence, to immobilize the pelvis and the foot at the same time, and with this end in view the Sayre-Wolf coxitis splint may, among others, be resorted to. This is the method advocated by Neudörfer.

J. v. Heine[53] has described a number of useful orthopedic apparatuses for the correction of genu valgum. Among others we note the following: He applies a plaster bandage to the limb extending from the toes to the perineum. He imbeds in this on the outside of the limb, above and below, iron stirrups, the lower one carrying a small wheel. An elliptical piece is cut from the bandage on the inner side at the knee, and a splint is adjusted on the outer side of the limb. There is a groove in this splint in which the wheel fits, when the knee is drawn against the splint. Rotation of the lower extremity is impossible when this apparatus has been adjusted,

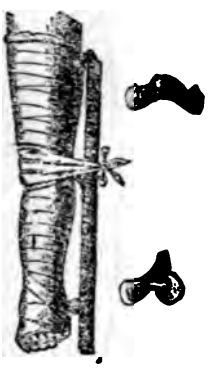


Fig. 207.—Heine's Plaster Bandage, with Splint.

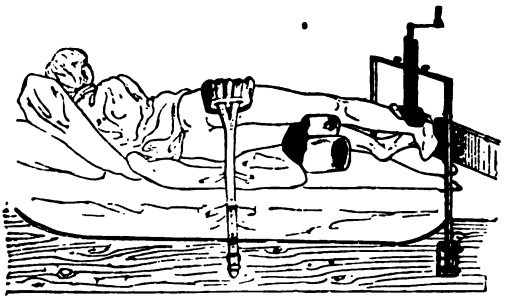


Fig. 208.—Heine's Apparatus for the Treatment of Genu Valgum.

and gradual redressement of the deformity is attained. The apparatus in position is shown in Fig 207.

A second method of treatment requires rest in bed. The patient is placed on the side, one leg is bent out of the way, and the other is straightened against a conical cushion which rests behind the knee. Pressure is exerted over the malleolus by a screw-mechanism which is attached to the foot of the bed. The pelvis is firmly strapped down. The pressure exerted by the screw is at the outset gradual, and is increased as the patient becomes accustomed to the position. Fig. 208 amply explains the procedure.

The special apparatus which, for evident reasons, is only applicable to older children and adults, consists, ordinarily, of two longitudinal steel bars, which articulate at the knee and are provided with mechanism by means of which abduction

is possible. The upper and the lower extremities are immobilized by straps and a suitable knee-cap controls the knee. The entire apparatus is attached to the pelvis by a pelvic band, and it articulates below with a special shoe. Apparatus of this nature may be worn in walking, and the deformity is gradually overcome by screw pressure. Heine, Lonsdale, Beely and others have perfected such apparatus.

A further variety of apparatus utilizes the inner projecting side of the knee as a fulcrum, the lower portion of the extremity being drawn against a horizontal splint, placed along the inner side of the limb. Hester, of Oxford, has devised appara-

FIG. 209.—Apparatus for Bi-lateral Genu Valgum.

FIG. 210.—Hester's Genu-Valgum Apparatus.

FIG. 211.—Tuppert's Genu-Valgum Apparatus.

tus of this nature, and it has been modified by Heather Bigg. It consists of two arms of a lever united at the level of the internal condyle of the femur by a ring, the whole having the shape of the normal extremity. The upper portion is strapped to the thigh, while the inferior portion of the extremity is drawn to the lower part of the apparatus by well-padded straps as firmly as the patient can bear.

Apparatus with articulated joints may quickly get out of order, and the non-articulated is therefore not alone simpler but also more effective.

Tuppert's[54] apparatus (Fig. 211) may be recommended as very simple for the treatment of knock-knee in adults. It

consists of a flexible rod, one and one half inches broad, and about an inch thick, and the ends of which are inserted into brass plates. The plate for the femur is larger than that for the lower extremity, and they are strapped to the limb as shown in the figure. By means of a knee cap, the knee is drawn to the rod, the elasticity of which tends to restore the normal position to the limb. During the first fortnight the patient must sit or recline; thereafter he may walk around, and, as a rule, the deformity is overcome in from four to six weeks. At the end of two to three months the apparatus may be removed.

For the treatment of genu valgum infantilis every apparatus is open to objection. Landerer's method of elastic traction may be considered the simplest. It exerts a continuous pressure on the internal condyle, thus checking the tendency to excessive growth, and it removes pressure from the external condyle. The extremity has thus an opportunity to return to the normal curvature. The method consists in the use of two fan-shaped pieces of plaster, connected together by an elastic band. One piece is applied to the inner side of the thigh, and the other to the inner side of the lower extremity, the elastic band between the two being stretched, and the limb is then bandaged. Children may play around while wearing this apparatus and the pain caused by the exerted tension soon abates. In cases where the deformity is slight, the bandage need not be changed often; in cases of a higher grade, where the angle formed is 145° to 155°, four applications are requisite, or two to three months' treatment is needed. Only in the most aggravated instances do six to nine months elapse before the deformity is overcome. In Fig. 212 is represented a case of genu valgum in a female infant of five years, who was first treated by Tuppert's splint, and on account of rotation this had to be removed. Landerer's method was then resorted to, and in four months the case was cured (Fig. 213).

For dispensary treatment of children, the plaster bandage is useful. The child should be anesthetized and the deformity is corrected manually as far as possible. A plaster bandage is then applied, the knee being pressed outward. After the lapse of a few weeks the bandage is removed, the deformity further corrected, and a second bandage applied. A point on which stress must be laid is the necessity of placing a com-

press on the thigh above, and below on the lower extremity, under the plaster bandage.

In older children and in adults, the plaster bandage associated with elastic traction, is a useful method for gradual correction of the deformity.

Mikulicz[55] applies a plaster bandage to the limb in its pathological position. An articular anterior and posterior iron splint is imbedded in this bandage, as also two stout hooks on the inner side of the thigh and of the lower extremity. After the bandage has hardened a wedge-shaped piece is cut out from the inner side at the level of the knee, and on the outer side at the same level the bandage is cut transversely.

Fig. 212.

Fig. 213.

The two portions of the bandage are then simply held together by the points of the splints. An elastic band or a spring is next attached to the hooks, and the deformity is gradually overcome by the tension. In moderate instances of genu valgum Mikulicz, as a rule, succeeds in a few weeks. (*Vide* Fig. 214.)

Vogt[56] has essentially modified Mikulicz's method. He uses either the silicate of soda or the leather bandage, and I am in the habit of following his procedure in my clinic.

The differences between Mikulicz's and Vogt's procedures are apparent from a comparison of Figs. 214 and 215.

Hüter advocates applying the plaster bandage with the limb flexed, since thus he obtains diminution of the unequal pressure. He has in this way reached excellent results in

cases of rachitic genu valgum, especially when the knee was drawn outward during the application of the bandage. Other observers (König, Waitz), however, have not had the same results from the method. If now we consider these various mechanical methods of treatment of rachitic genu valgum we find that, aside from many objections to which they are open, they often require a protracted application and the final result is frequently unsatisfactory. For these reasons the aim has been to devise methods more rapid in action. Tenotomy of the biceps, and section of the external lateral ligament have been in vogue for a long time, and after these methods the

Fig. 214.—Mikulicz's Plaster Bandage.

Fig. 215.—Vogt's Plaster Bandage with Elastic Traction.

deformity has been overcome to a greater or less degree. Délore[57] as the result of 200 observations has elevated rapid correction (*redressement brusque*) into a recognized method of treatment. It has frequently been resorted to successfully in Billroth's clinic, and Mikulicz[58] recommends it in cases of genu valgum infantilis where the desire is to avoid protracted treatment. By this method the epiphysis is fractured and the external ligament is torn from the lower end of the femur. Following Délore's method, the patient lies on the deformed limb and is anesthetized. The trochanter is utilized as the fulcrum, and the lower limb is held by an assistant. The projecting internal condyle is struck sharply until the deformity is overcome. Mikulicz claims that repeated attempts at re-

dressement will give more certain results, seeing that thus there occurs gradual separation of the epiphysis.

Tillaux[59] places the internal condyle on the edge of a table as the fulcrum and uses the lower extremity as the lever, straightening out the limb at once. From three to six weeks thereafter a fixed dressing must be worn.

Vogt's[60] researches have proved that the fear of disturbances in growth, etc., after the above separation of the epiphysis is unfounded. While Schede, Maas, and others recommend such measures only in case of small children, Gussenbauer applies them as well in the treatment of genu valgum in adults.

Next to manual reduction of the deformity we must consider instrumental measures, or osteoclasis by means of special apparatus as practised even by Hilppocrates, P. v. Aegina, and others. For this purpose we may use the osteoclasts

FIG. 216.—Rizzoli's Osteoclast for the Treatment of Genu Valgum.

devised by Rizzoli, Bruns, Volkmann, Beely. Especially brilliant results have been obtained from Robin's instrument.[61] Collin's instrument (Fig. 36) received the prize of the Paris Academy. Pousson claims that osteoclasis is an effective and a safe method of curing genu valgum.

In all cases of considerable genu valgum in old children or in those in whom the bones have already hardened and where gradual treatment would require too much time, or cannot be instituted owing to the social condition of the patient, the surgical methods of treatment must be considered. Especially is this the case about the twentieth year when the epiphyses have become ossified and where in consequence results can only be obtained through resort to operation. In these days of careful antisepsis the surgical methods are safe and in a few weeks cure is complete. Anesthesia and Esmarch's bandage materially lessen the difficulty of the operation.

Ogston's operation[62] (1876) of osteoarthrotomy or condylotomy with the saw, although, when performed antiseptically, it appeared rational, has to-day been replaced by better methods owing to the fact that it is based on the false premise of greater length of the internal condyle.

Ogston operated as follows: After careful disinfection of the field of operation and with careful antisepsis, the knee was sharply flexed and a slender knife about two and one half inches long was inserted obliquely above the internal epicondyle down to the bone. On withdrawal of the knife the tissues down to the knee were cut. An Adams' saw was next introduced into the opening and the internal condyle was sawn obliquely from in front backward. The deformity was then

FIG. 217.—Ogston's Operation for Genu-Valgum. *a*, Schematic Representation of the Deformity; *x*, Point of Entrance of Saw; *b*, Limb after Correction.

FIG. 218.—*a*, Genu Valgum in an Adult Before Ogston's Operation; *b*, After this operation.

forcibly corrected, and the limb was encased in a firm dressing.

Although in about 300 operations, performed, among others, by Nussbaum, Thiersch, Kolaczek, Sprengler, Partsch, Bardeleben, Graeff, and others, a straight limb with movable joint was obtained, there occurred still instances where the operation was accompanied by much hemorrhage or was followed by suppuration (Sonnenburg, Schönborn), paralysis of the peroneus muscle or partial ankylosis. The operation has also been followed by death (Graeff, and others), and therefore not only have König, Volkmann, Mikulicz, and others characterized the method as a faulty one, but Ogston himself has rejected it for MacEwen's osteotomy.[63]

In 1879 Reeves endeavored to avoid certain of the accidents likely to follow Ogston's operation (such as the breaking off

of pieces of the saw in the joint) by performing condylotomy with the chisel. After making a small incision through the skin and the periosteum above the most projecting portion of the internal condyle, he applied the chisel obliquely to the bone and struck it in an outward direction. He next chiselled backward a trifle and then straightened the limb. After the lapse of two weeks he applied a permanent bandage which was worn from six to eight weeks. The more the cartilage is avoided in the operation the more certain the result.

From Mikulicz's observations osteotomy of the bones implicated in the formation of genu valgum is to be preferred to an operation on the joint. The supracondylar osteotomy of MacEwen,[64] is a simple operation and more certain in result. This operation avoids the epiphysis, the joint and the ligaments; the wound under antiseptic precautions unites by first intention; the method is not dangerous and it answers in its aim most correctly to our view of the pathology of genu valgum; it is further applicable to the majority of instances of the deformity.

MacEwen operates as follows: The patient is anesthetized and Esmarch's bandage is applied. The limb is thoroughly disinfected, laid on a sandbag and held firmly under the spray, and with a sharp-pointed knife a longitudinal incision is made a finger's breadth over the upper border of the internal condyle, and one and one half inches in front of the tendon of the adductor magnus. This incision is continued down to the bone and is made large enough for the introduction of the osteotome or even, at times, of the finger. The bistouri acts as a guide for the osteotome; the former is withdrawn and the latter is placed transversely to the bone, and is carefully driven in until it reaches the posterior border of the bone. The osteotome is next directed from before backward against the external and posterior edge of the femur.

In case of soft bones it suffices to divide the bone for two-thirds of its thickness. Where the bone is hard and brittle the section must extend just under the superficial compact layer and the remaining bridge of bone must be slowly fractured while a carbolized sponge is pressed against the wound. The limb is dressed antiseptically on a long lateral splint, and this dressing is not disturbed for a few days, unless the temperature rises above 38° C.

This method has been resorted to by Schede,[65] Maas, Trendelenburg, Schönborn, Brüns,[66] Willet, and they have almost uniformly obtained good results. A number of deaths have still been reported by MacEwen, Hofmokl, Schede; nevertheless this operation is to be commended in ninety cases out of one hundred and Middeldorpf[67] justly calls it the operation of future.

In performing MacEwen's operation Poore[68] bends the knee at a right angle, since thus he is better able to determine the mid-line, the extremity can be held to better advantage, and when the limb is straightened after the operation, the skin covers the wound in the muscles.

Reeves, Gussenbauer, Czerny and others have recommended

Fig. 219.—Genu Valgum Before and After Operation.

Fig. 220.

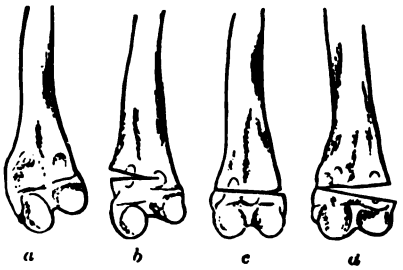


Fig. 221.—*a*, The Deformity to be Corrected; *b*, the Internal Incision; *c*, the same after Correction of Deformity (MacEwen); *d*, Correction after Incision in the Outer side.

and performed supracondylar osteotomy on the outside of the limb. MacEwen's operation has, however, been most frequently performed. MacEwen has done it 820 times; it has been resorted to about 1,384 times in England, and of this number ten died, although only three succumbed to the operation. In Germany also the operation has found great favor.

MacEwen claims for his method that the defect in the bone made by the osteotome is filled in when the limb is straightened, and that only in the worst cases is the bone slightly fractured on the outside and this is covered by the periosteum. Where the section is made externally, however (Fig. 221), a greater cleft results, and this is filled in more slowly. Further, he thinks that the latter method entails greater injury to the soft parts, in which the femoral artery may be involved.

Osteotomy through the diaphysis is certainly the simplest operation, yields very good results, and avoids a number of untoward sequelæ common to other methods. It is recommended by Billroth, Neudörfer, Reeves.[69]

It is performed by repeated boring through of the bone through an external incision midway between the middle and lower third of the femur. Reeves resorts to it without antisepsis or Esmarch's bandage; Billroth selects the site one and three-quarter inches above the condyles; Neudörfer uses the chisel without previous incision. The limb is bandaged and

Fig. 222.—Genu Valgum. MacEwen's Operation on the Left, Orthopedic Treatment on the Right Side.

Fig. 222 a.—Condition of the Limbs Six Weeks After Beginning of Treatment. Left Leg Straight.

this is ordinarily only changed after consolidation of the bone, that is, in from four to five weeks.

If after correction the extremity is not as long as the other, then extension must be applied. We are dealing indeed with a simple fracture of the femur, which frequently unites with slight dislocation, the upper fragment projecting outward anteriorly.

Osteectomy on the femur is somewhat more complicated.

In general, the wedge-shaped excision at the inner condyle has found but few adherents.

This operation, as described by Chiene,[70] is performed as follows: An incision from two to three inches long is made parallel to the long axis of the bone, beginning one-half an inch below the tubercle of the internal condyle and extending above it. On incising the fascia, the tendon of the adductor magnus is laid bare. The wound is extended between this tendon and the fibres of the vastus internus, the arteries are ligated and severed. A cruciform incision is made into the periosteum and this is pushed up till the bone is exposed. A wedge-shaped piece is next removed with the chisel and hammer from the base of the condyle, just above the tubercle where the tendon of the adductor is inserted. The breadth of the wedge varies according to the degree of deformity, its long axis extending downward and outward toward the intercondyloid groove. The wedge thus lies on a higher level than the epiphyseal line and its apex may reach this.

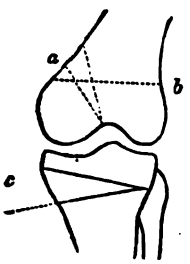


FIG. 223.—Genu Valgum Operations. *a*, MacEwen's; *b*, Annandale's; *c*, Schede.

MacEwen,[71] Mazzoni, and others chisel the wedge outside of Ogston's line (Fig. 223, *a*), its apex lying in the cartilage of the joint. The joint is not opened, and on correction the inner condyle is not fractured, but only pushed up. MacEwen, however, rejects this procedure on the ground that it is difficult of performance and uncertain in its results, compared with his linear osteotomy.

From his experience with genu valgum Neudörfer has performed and recommended osteotomy across and below the trochanter, and this is less risky than osteotomy of the diaphysis of the femur, where the canal of the bone is opened.

Operations on the tibia were performed at an earlier date (Mayer and others) than those on the femur, and where the chief deformity involves the tibia (as in rachitic instances) such operations are the most rational (Mikulicz).

Linear (subcutaneous) osteotomy is performed after Billroth as follows: Under antiseptic precautions a transverse incision one-half an inch long is made with the chisel, three-quarters of an inch below the spine of the tibia, extending through the skin and the periosteum. The compact portion of the outer surface of the tibia is then cut transversely, and the rest of the bone is

fractured. The limb is dressed antiseptically and a plaster bandage is either at once applied and left for three to five weeks, or else this bandage may be put on at the first change of dressing.

Mikulicz,[72] Gussenbauer, Volkmann, Middeldorpf, and others have reported numerous cases treated after this fashion.

Schede performs wedge-shaped osteotomy of the tibia and linear section of the fibula, an operation which Volkmann, Maas, and others also favor and which, in rachitic cases, where the deformity involves chiefly the bones of the lower extremity, is to be preferred to others. In the case represented in Fig. 42 a straight limb was hereby obtained.

Fig. 254.

König makes a longitudinal median incision, about three and one-half inches long, through the skin and the periosteum, beginning one-half an inch below the spine of the tibia. A second incision is then made transversely and at right angles to the first, overlapping to a degree the lateral border of the tibia. The triangular skin and periosteal flaps are retracted and the periosteum from the inner and the outer ends of the incision is loosened. A sufficient wedge is then removed with the chisel to overcome the deformity, and it is essential to cut entirely through the lateral wall of the tibia. The wound is sutured, dressed antiseptically, and as soon as consolidation has occurred König allows his patients to walk. From six to eight weeks are required for union and six months before complete restoration of function.

For the great majority of cases the varieties of osteotomy suggested and resection as performed by Bauer, Annandale[73] and others are only of historical interest.

Under the term genu varum (*genu extrorsum, Säbel-Bein, genou en dehors,* bow leg) is understood the opposite condition to genu valgum. It is an adduction contracture of the knee-joint. The knee deviates outward from the normal line of the leg (*ac*, Fig. 224).

The essential seat of this deformity is almost never in the knee itself. The lower end of the femur may be alone affected

or the curvature may involve a greater extent of the limb, in particular the upper portion of the tibia, which is often also curved anteriorly. Rachitis is here also the etiological cause, and genu varum cannot be sharply differentiated from rachitic deformities of the lower extremity, for both are usually associated, and genu varum is caused by a rachitic bending of the bone near the knee-joint. Genu varum is chiefly met with in children. It may be unilateral or bilateral, and in the latter event the legs form an arc. Very exceptionally genu valgum of one side is associated with genu varum of the other (Fig. 225).

Fig. 225.—Slight Genu Varum of the Left Extremity and Genu Valgum of the Right in a 17-year-old Rachitic Subject.

The anatomical changes are those which are characteristic of rachitis. The lower end of the femur may be developed at the expense of the external condyle, the line of the knee-joint extending obliquely from within outward. The external ligament is stretched; the internal lateral ligament is tense; the essential seat of the process is in the bones, the tibia being curved to an angle opening inward (Fig. 225)—a curvature which can rarely be considered as due to infraction, but rather to disturbances in growth at the diseased epiphyseal line. In addition the diaphysis of the bones of the lower extremity is characteristically flattened out.

The symptoms of genu varum are, in addition to the diminished height of the individual, the hideous method of walking with the outward curvature of the region of the knee. Security in progression is not so much affected as it is in case of genu valgum.

The treatment in the initial stage in children consists in forbidding walking in order to spare the soft bones the effects of pressure.

As soon as the deformity becomes evident, manual correction and fixation by a suitable apparatus are indicated. These aims are best fulfilled by applying an internal lateral splint thoroughly padded near the internal malleolus, and by making elastic traction on the knee against the splint.

For older children a variety of apparatuses is at our disposal. The essential of the majority is a splint against which the extremity rests, the knee being drawn toward the splint. In other apparatus the point of greatest curvature is used as the fulcrum, and the lower end of the leg is drawn against an external splint. In bilateral genu varum of slight degree, a stout cushion may be placed between the feet and the curved extremities may be drawn together by elastic traction.

The apparatus for ambulant treatment consists of two iron blades fitted to the shoes, with a joint at the knee. Against these blades the knees are held by elastic traction; or else the lower extremity may be gradually straightened by the action of a spring splint fastened to the leg.

Complicated apparatus, such as that of Heather Bigg, is open to objection, and the tendency in case of much deformity is to resort to operation. At the age of about two years and under, as a rule, the leg may be straightened manually, under anesthesia, and if a suitable fixation apparatus be then applied, and anti-rachitic remedies administered, the result will ordinarily be a permanently good one. In older children forcible straightening (Délore) or else osteoclasis (the fracture of the bones, usually at the upper third of the lower extremity) are measures to which we may resort.

Where the deformity affects chiefly a single bone, such as the tibia, and this bone has sclerosed, that is to say, the rachitic process has become cured through sclerosis, then manual straightening is no longer to be thought of, and the instrumental means at our disposal find their application.

A simple linear osteotomy (Langenbeck), performed preferably with the chisel, as a rule will suffice to straighten the limb, and only in case of great deformity is it requisite to resort to a wedge-shaped osteotomy.

In Fig. 226 is represented a case of Middeldorpf's where he performed linear osteotomy on the tibia of a patient aged nineteen, and removed a wedge from the fibula. The result is shown in Fig. 226 *b*, the cure being complete.

In exceptional instances, the deformity is so great that repeated osteotomies are called for. MacEwen[74] records a case where osteotomy was performed ten times before the limb was straightened.

Theoretically, where the tibia is curved, its outer side should

be incised and chiselled and the inner side should be fractured, but it is simpler to cut the inner superficial portions together with the external wall of the tibia, and the fibula must also be chiselled in case it cannot be bent or fractured.

Resection, in case of genu varum, as performed by Howse,[75] is scarcely indicated.

The rarest form of deformity of the knee is the genu recurvatum. The condition here is one of hyperextension, the thigh forming with the lower extremity an angle opening forward. This deformity may be congenital (Kleeberg, Chatalain, Maas, and others), or acquired from inflammatory (tabetic affections of the joint, Westphal and others) or due to traumatic

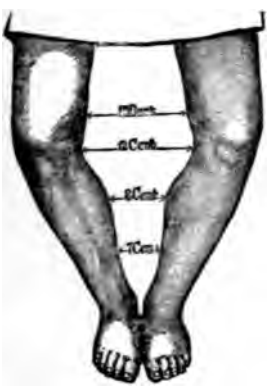


Fig. 226 a.—Genu Varum.

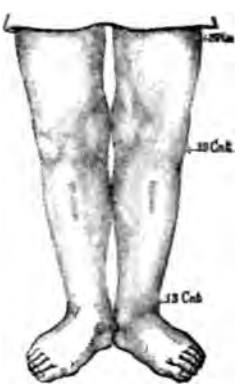


Fig. 226 b.—The Same After Osteotomy.

Fig. 227.—Genu Recurvatum.

cause. Usually this deformity is of paralytic origin (Hüter), the movements of the joint not being limited by the normal muscles, and the ligaments being relaxed (Fig. 227).

This deformity may be so marked that, as in a case reported by Bauer, on the assumption of the dorso-recumbent position the limb projects vertically upward. As a result of this deformity, the gait becomes uncertain, the pelvis sinks on the affected side and occasionally a static skoliosis develops. The treatment depends on suitable apparatus.

III. Rachitic Curvatures of the Diaphyses.

We have seen that a large proportion of the curvatures affecting the knee are rachitic in origin; similarly the curvatures of the diaphyses are caused by the same disease.

Rachitic curvatures of the femur are of little interest, seeing that we cannot do much in the way of treatment. Schede's vertical suspension in case of small children, osteoclasis, osteotomy in the worst instances, these measures are at our disposal.

Of far greater importance, owing to their frequency, are the rachitic curvatures of the lower extremity (crus varum). These curvatures affect in particular the lower third of the extremity. The curvature is ordinarily met with in the anterior plane, although curvatures in various planes occur, giving rise to the characteristic badger-legged deformity. Exceptionally the curvature is regular, and usually there is a sharp

Fig. 228.

Fig. 229.

Fig. 230.—Rachitic Curvatures of the Lower Extremities.

bend a few fingers' breadths above the ankle-joint, where an angle exists (Fig. 233), the feet gradually assuming a position similar to that of flat-foot. In exaggerated instances the deformity is not only a hideous one, but the function of the limb is materially interfered with. This almost always yields to the pressure of walking or standing, and after the cure of the rachitis there remain changes in the bones. The bones which were formerly abnormally soft become sclerotic, and have been bent and flattened by muscular action in a characteristic manner (Fig. 231).

In connection with this deformity we often speak of equalization of the deformity by growth, and unquestionably, even in instances of great deformity, the formation of new bone, in course of time, gradually fills in the concavity of the curvature, and the limb may become entirely straight.

These curvatures, however, in the majority of instances become permanent and call for special treatment. As soon as the deformity is noted, the child should, as far as possible, be prevented from walking and standing, and the ordinary anti-rachitic remedies may arrest the changes in the bones. The application of splints and of extension apparatus may also prove serviceable. The simplest apparatus is a long internal wooden splint, well padded at each extremity, to which the limb is drawn by one broad or by a number of slender elastic straps.

The majority of orthopedic apparatus suitable for these cases (Heather Bigg,[75] Salt,[76] Ford[77]) consist in one or two lateral splints fastened to the leg at the knee and foot, and with elastic straps for traction on the limb above the convexity of the curvature.

Figs. 231 and 232.—Marked Curvature of the Lower Extremity with Anterior Angle.

When the curvature is purely anterior, the best apparatus consists in two lateral bars with ankle-joint attachment, splints for the calves, and a leather cap for application in front over the curvature and gradually tightened to correct the deformity.

Where, however, the deformity is very marked and the patient is an infant, then an orthopedic apparatus cannot be well applied. A forcible straightening of the limb, even if this results in fracture, is the method which will yield the speediest result.

Forcible straightening of the limb is accomplished readily by grasping the lower extremity above and below the deformity, placing the thumbs on the most projecting portion of the curvature, and then the exertion of a gradually increasing force will accomplish the aim, ordinarily without any crepitant sound.

Where simple manual osteoclasis will not suffice, then the osteoclast of either Robin, Collin, or Beely may be resorted to. If this instrument be not at hand, and the bones are sclerosed and therefore cannot be broken manually, then osteotomy is indicated.

Figs. 233 and 234 prove how even marked deformity may be relieved by osteotomy. The patient was thus cured by me

the present year. A short incision down to the bone is made over the most superficial portion and the tibia is then nearly chiselled through and the remnant broken, or else a wedge-shaped piece is removed. The periosteum, of course, is pushed to either side.

The fibula, which is ordinarily flattened, must usually also be cut. The so-called vertical osteotomy of Ollier possesses certain advantages in that shortening of the limb is less likely to result.

It is rarely essential to perform tenotomy of the tendo Achillis in order to maintain the limb in the correct position.

Figs. 233 and 234.—Rachitic Curvature of the Lower Extremity Before and After Osteotomy. N, Cicatrix.

Fig. 235.

Ordinarily it is sufficient to apply an antiseptic dressing, and then a firm bandage is to be worn a few weeks.

In Fig. 235 is represented the result after wedge-shaped osteotomy of the tibia and linear osteotomy of the fibula, performed on the limb shown in Fig. 232.

Albert [78] has performed six wedge-shaped excisions on the tibia in succession and obtained union by first intention and good consolidation without the slightest suppuration or rise of temperature. I have obtained a similar result in five severe instances operated upon during the past few months. In only one case did a small fistulous opening remain for a few months after normal consolidation. This fistula closed after the separation of a small sequestrum.

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CHAPTER VI.

CONTRACTURES OF THE FOOT.

UNDER the term Talipes (club-foot, pied bot, pes contortus) are grouped together those deformities which consist in an abnormal position of the foot, or of its divisions, in relation to the leg or to each other. Since we usually find alterations in the fasciæ and ligaments, and retraction of certain muscles, these deformities are also termed contractures of the foot (*Fusscontracturen*). A division is commonly made into contractures of the ankle (talo-crural) joint and contractures of

FIG. 236.—Talipes Equinus.

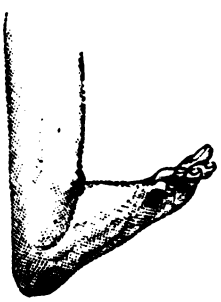


FIG. 237.—Talipes Calcaneus.

FIG. 238.—Talipes Varus.

the tarsal joints. Under the first head we have: 1. Talipes equinus (flexus) (Fig. 236), in which there is abnormal extension (plantar flexion) of the foot; 2. Talipes calcaneus (extensus), in which the foot is flexed dorsally, and the heel seems to be lower than normal (Fig. 237).

The contractures of the tarsal joints, where, in addition to a vertical displacement, there is also a deviation in other directions (adduction or abduction, pronation or supination), are divided into: 3. Talipes varus (flexus adductus inflexus), in which there is supination or adduction (Fig. 238); 4. Talipes valgus (extensus abductus) or flat-foot, in which the contrac-

tion is in a direction of pronation or abduction (Fig. 239). We have also, according to the condition of the plantar arch: 5. Talipes planus (reflexus) or flat-foot, in which the arch is sunken, the anterior portion of the foot, at Chopart's joint, is in a manner bent upward, and the entire sole rests upon the ground (Fig. 239); 6. Talipes cavus (inflexus), in which the arch is higher, the sole seems excavated, the anterior portion of the foot, at Chopart's joint, is bent downward, and this part and the heel are nearer each other (Fig. 240). In the great majority of cases none of these deformities exists alone, but they are usually combined, as, for example, in talipes equinus there is usually more or less deviation to the inner side (talipes

Fig. 239.—Pes Valgus.

Fig. 240.—Pes (Calcaneo) Cavus.

equino-varus), or the heel is depressed and the foot is pronated and abducted (calcaneo-valgus).

Without doubt, hereditary influences are concerned in the production of club-foot, and deformities of this kind may often be traced through several generations. Indeed, talipes has not infrequently been noted in the fœtus (Little, Parker). K. Roser[1] found among 100 malformed fœtuses, 36 in which there were deformities of the feet. Of these there were 8 cases of double talipes varus, 11 of double calcaneus, 9 in which both varus and calcaneus existed, and 9 in which there was unilateral deformity.

Deformities of the foot may be either congenital or acquired. The former are usually bilateral, and consist in an abnormal shape and position of the bones of the foot, more particularly of the tarsus. Acquired club-foot is most commonly consecutive to disease of the nervous system (neurogenous), in which the cause of the deformity lies outside of the foot; less frequently it follows disease of the bones or joints (arthrogenous), or occurs as a result of fracture or subluxation (traumatic).

The relative frequency of these different forms varies greatly, but club-foot in general is of rather common occurrence. Stromeyer[2] calls it one of the great sources of human misery, especially among the lower classes, and says that in almost every large hamlet one or more individuals may be found whose existence is embittered by this evil, and who are hindered thereby from earning their living.

Many different theories exist as to the origin of congenital talipes, but we may here distinguish between the mechanical, and the dynamic (muscular) theories, and that of arrested development.

Hippocrates, Galen, Ambroise Paré, and others sought for a mechanical explanation of congenital club-foot, but Scarpa may be regarded as the scientific founder of this theory, for he looked upon it as a result of abnormal pressure of the uterine walls upon the affected parts. Although much has been written against the mechanical theory, and cases have been cited in which children were born with club-foot, notwithstanding the presence of a large amount of amniotic fluid, Cruveilhier was an upholder of it, and he has been followed by Volkmann, Lücke, Kocher, Vogt, Banga, Parker,[3] Conrad, and others. These authorities have instanced, in support of the mechanical theory, the presence of marks (Fig. 241) indicating pressure upon the prominent parts, although one could scarcely form a conclusion from the presence of these marks of the time at which the pressure was exerted. According to Parker and Shattuck's investigations[3] we may suppose that the feet assume different positions at different periods of intra-uterine life, and that any influences which hinder the feet from assuming the position that they ought to take at any particular period, or which keep them too long in any one position, may act as efficient factors in the production of talipes. Küstner[4] is, among others, one of the most active supporters of the mechanical theory, epecially as regards the production of varus and valgus, and he looks upon a certain degree of extension of the leg as specially favoring the production of flat-foot, since the pressure of the uterine wall thereby acts at greater advantage upon the sole of the foot, pushing it upward and outward.

Fig. 241.—Cicatricial Contraction. (After Parker.)

K. Roser and others look upon typical congenital varus and calcaneus as instances of a true deformity due to pressure.

The fœtus lies usually with legs crossed in such a way that the outer sides of the knees and feet lie close to, if not in actual contact with, the walls of the uterus. Any movement that the fœtus may make brings these parts against the inclined plane of the uterine wall in such a way as to increase the tendency to varus, which already exists in consequence of the flexion of the lower extremities against the abdomen. The production of calcaneo-valgus is explained on the assumption that the foot is in a position of dorsal flexion at the time that it comes in contact with the wall of the uterus. When the two legs are parallel, but disposed in such a way that the outer side of one only touches the uterine wall, the effect of pressure upon the feet is to produce varus in one, and valgus in the other. The mechanical effect is similar to that seen when one walks along the side of a slope, one foot being then forced into abduction and the other into adduction (K. Roser).

In rare cases one foot may be compressed against the other in such a way as to cause marked valgus in one, and equally marked varus in the other. The well-known case of Volkmann[5] is an instance in point, and Vogt[6] has also described similar cases.

Wolff[7] regards inward rotation as the primary position, and anything that hinders outward rotation of the extremities may cause talipes varus. Velpeau believes that, in addition to the position of the fœtus, its weight may also be of some moment in these cases.

Although congenital deformities of the feet may be explained from the standpoint of mechanical causes (Hencke, Hüter), that is to say, they are the result of pressure (Roser), a proportion of the cases must be considered as due to defective development, to a primary disturbance in growth of the affected bones and joints. This view is peculiarly applicable to those instances where congenital defect in certain bones has led to talipes, and to the additional cases where there coexists deformity of another nature, such as spina bifida.

The dynamic theory as to cause, in particular the view that the deformity is the result of unequal muscular traction (Duverney, Guérin, Stromeyer will certainly not apply to congenital talipes, since careful investigation has never revealed abnormity in the muscles.

The myo-neurogenous explanation of acquired talipes has also been rejected, even in instances of paralytic deformities, that is, those which were assumed to depend on disease of the central nervous system (myelitis, meningitis, encephalitis), such disease causing an entire or partial paralysis of special muscle groups. Hüter and Volkmann have shown that here as well mechanical causes are far more influential, and that the weight of the foot, in particular its anterior portion, plays an essential rôle. The soft parts, fascia and ligaments, and even the bones gradually adapt themselves to the altered position and the consequent effect is a retraction and shortening of the antagonistic muscles. In addition to simple weight which, even where the patient is confined for a long while to bed, may lead to the formation of pes equino-varus, the pressure resulting from walking increases the deformity, the foot assuming more and more an abnormal position. Where the bones are exposed to the greatest pressure growth is diminished, and where, on the other hand, there exists scarcely any pressure, the bones increase in size. Again, where the bones are but little in contact the cartilages disappear, while a new cartilaginous surface forms where the bones constantly move the one on the other.

Spasmodic deformities, such as are met with as an accompaniment of hysteria, etc., infrequently complicate instances of myo-neurogenous talipes, and the same remark holds for the congenital and acquired spastic contractures.

Talipes may also depend on traumatic causes. Cicatrices following burns, local injury to a tendon or nerve, may lead to the deformity. Very frequently badly united fractures or subluxation result in talipes. Witness talipes valgus dependent on union at an angle of the fractured external malleolus.

In general we may differentiate three degrees of talipes: 1. Where the deformity is not marked and we are able readily to bring the foot into the normal position; 2. Where it is just possible to correct the deformity; 3. Where correction is an impossibility, the deformity being permanent.

Although the anatomy and symptomatology of talipes must be specially referred to under the individual varieties, we would lay stress here on the fact that the seat of the deformity is not alone, as was formerly the belief, in the affected joint as an entirety, but far more in changes in the form of the

bones the result of growth in an abnormal direction. In very rare instances, for example in paralytic pes equinus, essential alterations in the bones and joints may be absent. As a result of abnormal pressure, etc., the direction in which growth takes place alters, as also the shape of the bones and of the ligaments. Callosities form on the part the least subjected to pressure and these may be the source of great suffering.

The sequelæ of talipes extend generally beyond the region of the foot. There occurs an atrophy of the muscles of the lower extremity or of the entire limb which, in comparison with the normal limb, is often most striking, and this atrophy leads to marked shortening. In the paralytic forms particularly, the temperature of the limb may be greatly lowered and it may have a bluish appearance.

The symptoms resulting from talipes, aside from the peculiar method of progression and the lessened ability of endurance, are chiefly painful affections, which render the affected individual entirely unable to perform certain duties. Where ulceration and inflammatory symptoms are superadded, the patient's condition may become so aggravated as to lead him to demand amputation, as the sole measure offering relief.

The prognosis of talipes naturally varies much according to its degree, variety, and time after formation when the patient comes under treatment. The earlier treatment can be instituted the more favorable, of course, the prognosis as regards cure of the deformity.

Modern treatment is so superior to the methods formerly in vogue that the prognosis is by no means as bad as formerly, when the patient had to content himself with the variety of apparatus mentioned by Dieffenbach.[8] The introduction of tenotomy into orthopedic practice marks the boundary between the methods of to-day and of the past.

The aim of treatment in case of talipes is to restore the foot to its normal position with respect to the lower extremity, to maintain it in normal position, and to correct the shape of the foot as far as possible.

Further still, particularly in case of the paralytic forms, we are called on to increase the nutrition and the function of the part by massage, passive movements, electricity, etc.

Since treatment should be instituted as early as possible after delivery, we naturally cannot speak at such an early

period of apparatus, etc. The following measures are chiefly of importance: movements aiming at reduction of the deformity; holding the foot for a few minutes in correct position; the application at night of bandages which will maintain the foot in position. These means are applicable to the congenital varieties until the skin becomes hardened, when plaster and permanent fixation dressings are to be resorted to, and we may thus obtain gradual correction of the faulty position.

The apparatus useful in the treatment of contractures of the foot may be divided into two classes: 1. Apparatus which aims at drawing the foot from the faulty into the correct position; 2. Apparatus which will maintain the foot in the position which can be secured. A further subdivision may be made into: 1. Apparatus which acts through elastic traction and pressure; 2. Apparatus which acts through constant traction and pressure, such as the plaster bandage.

Although certain apparatus may be adapted to any variety of talipes, owing to the possibility of altering the mechanism for applying the requisite traction, the majority of the contrivances under consideration were devised for special forms of the deformity, and must be separately studied.

For the congenital varieties of talipes, in addition to manipulations and manual correction, plaster and splint bandages may be resorted to for maintaining the foot in the position obtained by manipulation. Small splints made of rubber or felt or zinc (Smith, Vogt, and others) will in this connection be found very useful. Reeves has devised a good splint. The portions for the lower extremity and for the foot are connected by a ball-and-socket joint, so that when the splint is adapted the foot may be turned in any desired direction. The feet are placed in this variety of splint in the intervals between the manipulations, and thus gradual correction of the deformity is secured.

In the construction of foot-splints, leverage has also been aimed at. St. Germain's[9] *appareil en plaquette* consists of a foot-piece ABPT (Fig. 242) and a more or less vertical (according to the variety of deformity) portion AS. In the foot-pieces are two linear openings FF. The angles SAP and SAT may be modified in the construction to suit the variety of talipes to which the apparatus is to be adapted. Strips of plaster are applied to each side of the lower extremity (D in Fig.

243); these strips are passed through the openings in the foot-piece and are then brought over the foot, to maintain it in position. A circular strip of plaster (C) surrounds the calf of the leg to retain the vertical strips, and then by means of a bandage (B) the vertical splint is drawn against the legs and the deformity is corrected.

In case of older children the chief method of treatment has for long consisted in a retention bandage, changed from time to time, the foot being secured in as good a position as possi-

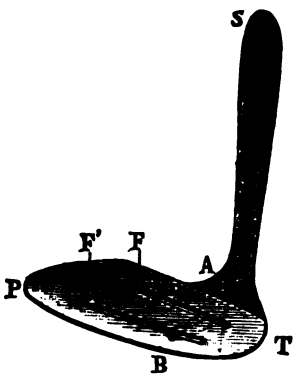


FIG. 242.

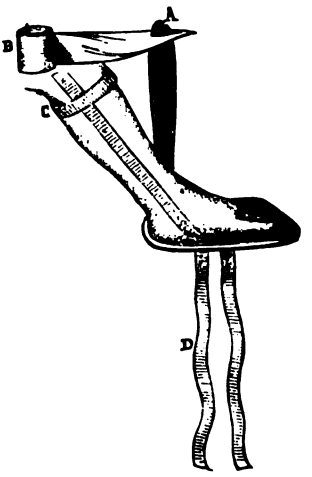


FIG. 243.—St. Germain's Splint.

ble. We will speak of this method particularly under the subject of club-foot.

Barwell's method of treatment by elastic traction through plaster is one of the simplest procedures, and it has been warmly indorsed by Sayre. It has the advantage of not interfering with the movements of the muscles and joints. A triangular, fan-shaped piece of plaster cut into a number of strips and carrying a wire loop (Fig. 244) serves as one point of attachment for the elastic traction, while a zinc splint (Fig. 245) on the front of the leg, and fastened to it by plaster, offers the second point of attachment. An elastic ligature extends between these two points and makes the desired amount of traction, the degree being regulated at will by a chain attached to the ligature (Fig. 246).

Blanc, Andrews, and others have devised similar appliances for the use of elastic traction. Andrews, for example, combines the plaster with an elastic band and utilizes a soft cushion as the fulcrum. Reibmayr has applied similar traction to talipes as to other joints.

Stillman has adapted Barwell's principle to an apparatus which is easily removed and applied to any shoe. It consists of an external splint for the lower extremity to which a number of elastic bands extend from the foot. This external lateral splint is bent backward from a point corresponding to the level of the ankle joint to the heel, where it is connected by a hinge joint with a short horizontal steel blade, to the anterior extremity of which the elastic bands are attached. At the

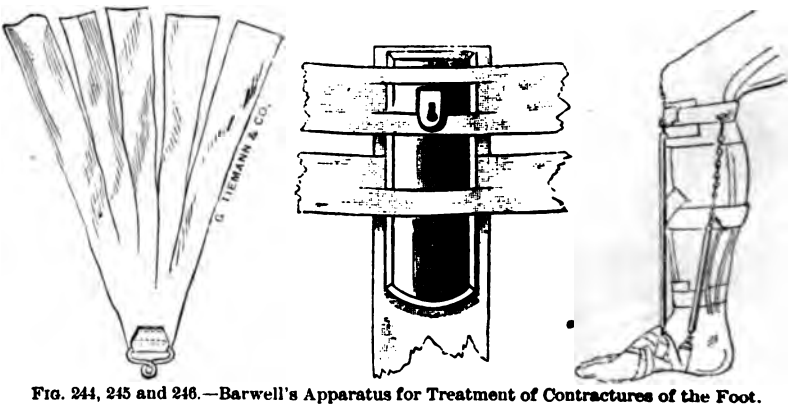


FIG. 244, 245 and 246.—Barwell's Apparatus for Treatment of Contractures of the Foot.

centre of the horizontal blade a shorter blade is attached, and this extends under the foot, and fits into a plate which is riveted into the sole of the shoe. Thus motions in the vertical axis only are possible.

Apparatus of this nature is especially useful in the paralytic variety of talipes. Beely's club-foot shoe may be taken as a type (Fig. 248). Sayre's shoe (Fig. 22) has a movable ball-and-socket jointed sole. The sole is metal covered with leather. Two lateral straight bars (B) extend from the sole, and in them, at the level of the ankle, there is a hinge joint (A). The bars are strapped to the leg at C. At the heel at J and on the sides of the sole at G there exist points of attachment for the traction chains which extend upward to the leg and backward to the heel. The chains or rubber bands (E)

act as artificial muscles. Apparatus of a similar nature to this has been frequently devised.

The Lück and Wolfermann shoe, devised for pes varus, valgus and equinus, is a further instance of a universal club-foot shoe which acts through elastic traction (*vide* Fig. 21).

Non-ambulant apparatus is also resorted to in the treat-

Fig. 247.—Stillman's Talipes Apparatus with Elastic Traction.

Fig. 248.—Beely's Talipes Shoe.

ment of talipes. Hansmann has devised an extension apparatus (Fig. 249) which he has tested chiefly in the Hamburg hospital. This apparatus enables us to maintain the foot in any desired physiological position and it is therefore useful, not alone in the treatment of fracture of this region, but also in case of talipes. This apparatus consists of a flat wooden splint, thirty-one inches long and seven inches wide, with an excavation for the reception of the heel. At its lower extrem-

ity it is united to a vertical wooden foot-piece, eleven inches high; at its centre and upper extremity, on each side, there are two vertical wooden bars from which counter-extension is made. A number of holes are bored into the foot-piece, into which hooked screws are inserted. The lateral upright bars carry leaden grooves in which similar screws fit. The carefully bandaged leg and foot are strapped to the longitudinal splint as is represented in Fig. 249. By varying the traction direction of the chains which are attached to the screws, the foot may be held in the desired position.

In the majority of instances, after the normal form of the foot has been approximately obtained, retention apparatus must be worn to prevent recurrence of the deformity. We will refer later to suitable apparatus of this nature.

In many cases tenotomy, especially of the tendo Achillis,

FIG. 249.—Hansmann's Extension Apparatus for Talipes.

materially shortens the time required for treatment, and whenever the contraction of this tendon is an obstacle to redressement it should be severed.

This operation may be performed with the patient lying either on the abdomen or on the back. In the first instance, tenotomy is performed from without inward, in the second from within outward. In any event the foot must be sharply flexed so as to cause projection of the tendon. A small incision is made at the edge of the tendon, a tenotome is inserted on the flat into the loose cellular tissue around the tendon, the edge of the instrument is turned toward it, and then rather by pressure (under the control of the thumb) the tendon is severed, as is evidenced by a loud snap. It is not ordinarily advisable to attempt correction immediately after tenotomy. It is preferable to wait until the slight wound has healed.

It is not often necessary to resort, in addition, to the section of other tendons, such as that of the tibialis posticus. In case

of great contraction of the plantar fascia, however, the subcutaneous section of the plantar aponeurosis may be called for. The transverse depression (Fig. 250) between the heel and the anterior portion of the sole of the foot is the site for incision. On dorsal flexion of the foot the aponeurosis projects at this spot, the tenotome is inserted either above or under it, and the shortened fascia is severed.

Of the apparatus formerly in use we will refer to Schuh's [10] club-foot appliance, since it is cheap and readily constructed by any locksmith. It consists of two separate portions: A foot-

FIG. 250.—Contraction of the Plantar Fascia.

FIG. 251.—Bruns' Club-foot Shoe.

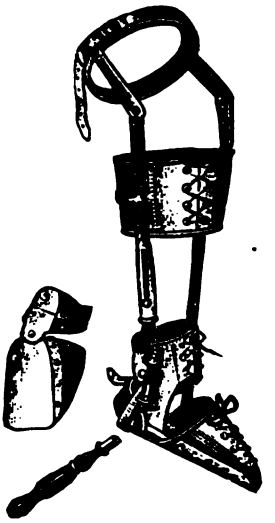


FIG. 252.—Kolbe's Club-foot Shoe.

piece of the size and shape of the sole of the foot of the patient, and a padded tin gutter which fits the lower half of the leg. From the edges of the gutter a stout ring projects An iron blade, which may be fixed at any angle, is attached to the gutter, and the bandage which holds the footpiece to the sole of the foot is drawn over this bar and the foot may thus be maintained in any desired position. Bardeleben [11] has substituted for the ring two lateral vertical projections which are connected by a rectangular piece.

In v. Bruns' [12] apparatus for varus, valgus, and equinus, the correction force is applied by the hand of the physician instead

of by screw mechanism. The foot is maintained in the position in which it is placed by the surgeon, and by repeated manipulation and adjustment of the apparatus the normal position and function are gradually attained. The apparatus consists of three portions united by bolts and iron rods, and it is represented in position in Fig. 251. Kolbe's shoe (Fig. 252) is also intended for the correction of varus, valgus, and equinus.

Under the apparatus with screw mechanism Langgaard's[13] must be referred to. It is useful both in varus and in valgus. The foot fits into an ordinary tight shoe which is supplied with an endless screw mechanism, by means of which the lateral position may be altered. Extending up the posterior portion of the shoe to the level of the ankle-joint, where it is connected with an endless screw, is a curved bar the revolution of which straightens the foot. Although this apparatus will correct equinus deformity, Adams rejects it on account of the ease with which it breaks.

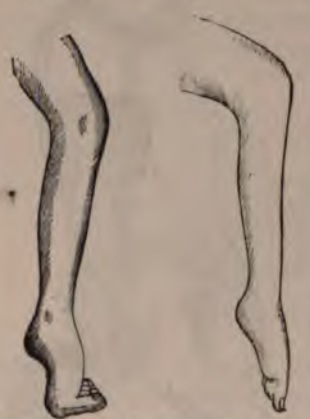


Fig. 253.—Pes Equinus. Fig. 254.—Pes Equinus Paralytic.

Talipes equinus (*spitzfuss, pferdefuss, pied bot équine*) is a deformity due to contracture of the foot in the position of plantar flexion. The heel is drawn upward, the apex of the foot downward without coincident lateral deformity of the foot.

The foot lies in a more or less straight line with the lower extremity. The patient walks on the metatarsal eminences. The foot is broad below, slender above, its longitudinal axis is shortened, whence its resemblance to the foot of a horse. In aggravated instances the patient walks on the dorsal surface of the curved toes, or even on the back of the foot (equinus dorsalis). Ordinarily there then coexists a certain degree of adduction and supination and there results the most frequent deformity: the equino-varus.

We must differentiate a pes equinus congenitus, although Tamplin rejects this variety and Adams and Little consider it very infrequent. As a rule, in the new-born, the motion of the foot in the sense of dorsal flexion is greater, and in the

sense of plantar flexion is less than in the adult. Pes equinus is more frequently acquired. The chief causes are: The effect of weight during protracted sickness (typhus, etc.), although this usually results in the pes equino-varus; inflammation of the joint, abscesses, etc., of the calf of the leg, traumatism in the same region such as burns (traumatic pes equinus); certain nervous diseases, hysteria, etc. (spasmodic pes equinus). Frequently pes equinus is of paralytic nature, the result of paralysis of the extensors, or a sequela of infantile paralysis or other central affection. We also meet with pes equinus as compensatory to shortening of the extremity due to one or another cause.

The angle formed between the lower extremity and the

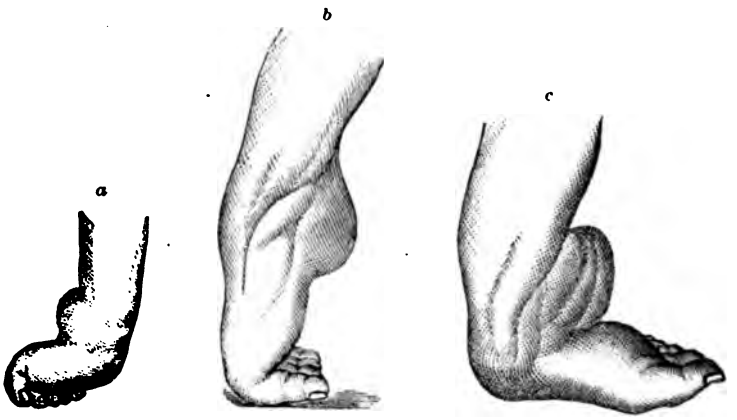


FIG. 255, a, b, c.—Aggravated Instances of Pes Equinus.

foot in mild instances is a trifle over 90,° in aggravated cases it may exceed 180°. According to the degree of deformity we may differentiate:

1. Instances where the heel is lifted upward, the toes are extended, the patient walks on the metatarsal eminences, the foot can still be placed at a right angle with the lower extremity (Fig. 253);

2. Instances where the retraction is greater, so that the axes of the foot and of the lower extremity are coincident;

3. Instances where the anterior portion of the foot is bent backward and the patient walks on the tarsal bones (Fig. 255, *c*).

In view of these varieties, the external appearances of pes

equinus differ very greatly. The foot appears to be shortened, its arch is deepened, the plantar fascia is, as a rule, contracted. The muscles of the calf, particularly in the paralytic variety, are markedly shrunken, and the entire lower extremity is atrophied. The leg, in consequence, resembles still more that of a horse. Ordinarily the head of the astragalus projects to a greater or less degree on the dorsum of the foot.

In instances where the dorsal surface of the foot is utilized in walking, the skin and the underlying tissues are thickened, bursæ are formed which become inflamed and are the source of pain. The deformity is thus greatly aggravated. In general, the degree of deformity depends on the state of the muscles. So long as the extensors functionate, the toes remain extended; while, when the anterior muscles of the lower extremity are paralyzed, the toes sink toward the plantar surface of the foot, and in aggravated cases the entire foot is retroverted (Fig. 255, *c*).

The walk of patients with unilateral pes equinus of slight degree is but little disturbed. Through flexion of the knee the increased length of the affected extremity is offset. In paralytic pes equinus, the individual drags the limb and swings it forward by circular movements. Frequently unilateral pes equinus of mean degree affects the individual more than a more aggravated type, the foot and the lower extremity functionating in a straight line like a stilt. Instances where the patient walks on the dorsum of the foot are always aggravated, especially when bursitis and ulceration complicate, and then the individual is practically helpless.

The walk of an individual with bilateral pes equinus is uncertain and lacking in normal elasticity.

The pathological anatomy[14] of pes equinus reveals rather an alteration in position than in the form of the parts which enter into the composition of the foot, except in the later stages of the deformity. In a case observed by Adams the bones of the foot were in every respect normal.

The astragalus is only in contact posteriorly with the tibia and the fibula, and projects on the dorsum of the foot (Fig. 256). The scaphoid is not infrequently subluxated, approaches the calcaneus and, in marked instances, articulates with it.

In severe chronic cases, only the posterior portion of the trochlea of the talus is covered with cartilage. In Dittel's

case, the caput tali projected above the upper surface of the scaphoid, so that the anterior articular surface of the astragalus was nearly two-thirds free (Fig. 256, *d c*).

The posterior portion of the calcaneus is lifted upward and in severe cases it may be in contact with the bones of the lower extremity; as a rule, however, its position is altered less than that of the other tarsal bones. Its anterior portion may be subluxated from the cuboid and be bare of cartilage. The metatarsi may even be in contact with the calcaneus. In Dittel's [15] case and in Chance's, new joint surfaces were formed between the tibia and the calcaneus and between the extremity of the fibula and the external surface of the calcaneus (Fig. 256, *a*).

Fig. 256.—Pes Equinus. (After Dittel.)

The tarsal bones, on the dorsal surface where the pressure is the least, increase more in size than on the plantar surface. The arch of the foot becomes unusually deep. If the toes remain in normal position (the individual being recumbent), then the metatarsi are subluxated when the individual is erect. The ligaments and aponeuroses take part in the abnormal changes. The ligaments (especially the talo-navicular) are stretched on the dorsal and shortened on the plantar surface of the foot. As a secondary change we must note the irregular course of the posterior tendons of the lower extremity. They form an acute angle forward as they pass over the heads of the metatarsal bones, while the extensor tendons may span the metatarso-phalangeal joints like a bridge.

Atrophy of the muscles of the calf is more or less striking. Pancoast's assertion that the soleus is almost or entirely retracted lacks anatomical confirmation.

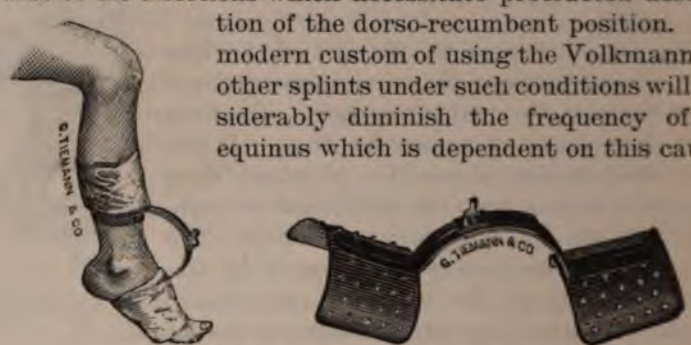
In making the diagnosis of pes equinus the knee must be extended, since, when the knee is flexed, a slight degree of equinus may entirely disappear, that is to say, it is possible to dorsoflex the foot to a greater extent.

The prognosis of pes equinus is, in general, good. The rare congenital form may ordinarily be readily corrected, as also the acquired form when of recent formation. When the deformity has existed for a number of years, the nutrition of

the joint has been deeply affected, and the component portions of the foot have adapted themselves to the abnormal position, then many obstacles are in the way of treatment. The paralytic variety, especially, calls for the protracted wearing of apparatus to prevent the development of a higher grade.

In connection with the treatment of pes equinus we must state that all forms do not call for it. The compensatory equinus, for instance, in case of shortening of the extremity, is a favorable occurrence, and then a thicker sole to the shoe will amply fulfil the indication.

The prophylactic treatment of pes equinus may be said to consist in applying suitable support to the foot during the course of all affections which necessitate protracted assumption of the dorso-recumbent position. The modern custom of using the Volkmann and other splints under such conditions will considerably diminish the frequency of pes equinus which is dependent on this cause.



Figs. 257 and 258.—Stillman's Apparatus for Pes Equinus.

In infants, manipulation, redressement, and fixation by splints will suffice to effect a cure. In older children, forcible repeated correction with the application of a plaster or a silicate of soda bandage will accomplish the aim. In severe cases of pes equinus, gradual correction after Stillman's method is possible. The splint shown in Fig. 258 is applied to the foot and the lower extremity. A plaster bandage surrounds the two portions of the splint, and these are gradually approximated by the screw mechanism in the bar connecting them (*vide* Fig. 257).

In the slighter grades of deformity the treatment is of the simplest possible kind. A piece of cloth may be looped around the patella, another piece around the foot and the two are connected by a third or by a strap whereby reduction may be gradually accomplished. Or, better still, a wooden foot-piece

may be attached to the foot and a cord may be extended from its anterior end upward to the patella, where it is fastened to a strap. By shortening this cord, gradual correction is obtained. Braatz's apparatus (Fig. 259) consists of felt splints for the foot and lower extremity, and of an iron articular frame-work fitting under the foot and along the front of the leg through which, by means of straps, the foot is drawn upward. Another method is to carry a broad strip of stout plaster under the foot and attach it to the anterior portion of the lower extremity.

Fig. 259.—Braatz's Equinus Apparatus.

Elastic traction has in a number of ways been applied to the treatment of pes equinus. One of the best known and still frequently used appliances is the Stromeyer apparatus (Fig. 260). Its component parts are: A posterior splint, *a*, with strap, *d*, a foot-piece, *b*, movable on an axis, *c*, attached to the foot by the strap, *e*, and cords passing laterally from the footpiece over rollers in the posterior splint and revolving on the cylinder, *f*. By means of this apparatus the foot may be dorsoflexed to the desired extent.

Since the individual may walk while wearing them, the

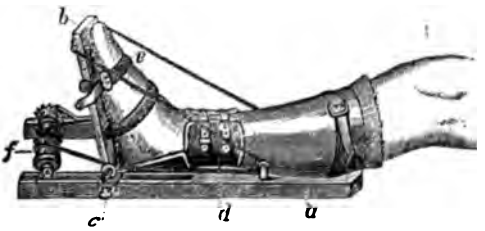


Fig. 260.—Stromeyer's Equinus Apparatus.

different apparatuses with elastic traction are more useful. Such appliances may be readily devised.

Davis, Bigg, and others recommend plaster spirals around the upper extremity, similar ones around the foot, the two

being connected by straps and rubber cords. Heidenhain[18] (Fig. 261) obtains elastic traction through a rubber ring combined with the spirals of plaster. A more efficient means is a firm bandage around the upper part of the leg carrying a hook or a ring, a similar one over the foot and an elastic band extending between the hooks along the anterior surface of the leg.

Many of the appliances with elastic traction are to a greater or less degree modifications of Bauer's (St. Louis) shoe (Fig. 262). This shoe has an iron sole articulating with which are two lateral bars strapped to the leg below the knee and at the ankle. A ring in the toe of the shoe serves for the attach-

Fig. 261.—Heidenhain's Equinus Apparatus.

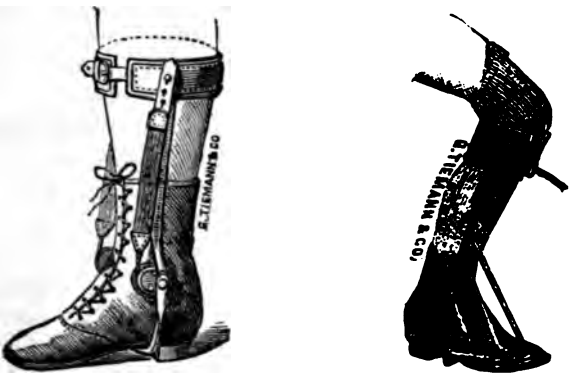
Fig. 262.—Kolbe's Shoe.

Fig. 263.—Sayre's Equinus Apparatus with Elastic Traction.

ment of the rubber band which dorso-flexes the foot. Sayre's apparatus (Fig. 263) answers the same purpose and may be fitted to the ordinary shoe. The lever instruments of Liston, Bigg[19] and others, Scarpa's shoe, apparatus with endless screw mechanisms (Parona, Langgaard) may also be utilized for the treatment of pes equinus. When, by one or another of these appliances, the correct position has been restored to the foot, the individual must wear an equinus shoe which will not interfere with walking, but which will prevent the recurrence of the deformity. These shoes have a hinge-joint adapted in them at the level of the ankle or they prevent plantar flexion through the action of elastic bands (*see* Figs. 264 and 265).

Tenotomy of the tendo Achillis unquestionably in the most

aggravated cases shortens the duration of treatment, and since this operation, performed subcutaneously, is entirely without danger, it should be resorted to. In case of paralytic pes equinus tenotomy will certainly rarely be called for. In

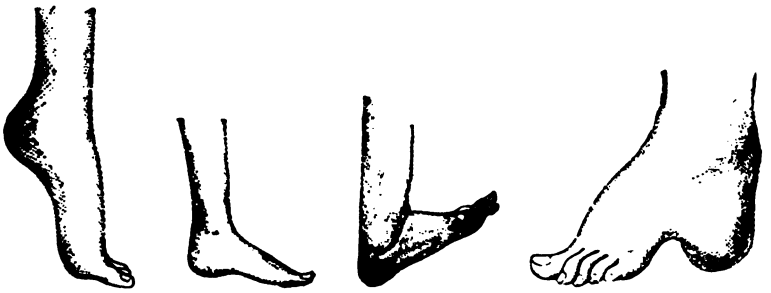


Figs. 264 and 265.—Stillman's Equinus Shoes.

Figure 266 (*a* and *b*) is represented an instance of pes equinus in a boy of twelve, before and after the performance of tenotomy.

As soon as the tenotomy wound has healed, a suitable apparatus must naturally be resorted to.

Occasionally, where pes cavus complicates pes equinus, subcutaneous section of the plantar fascia is requisite. Even



Figs. 266 a and b.—Pes Equinus Before and After Tenotomy. Fig. 267. Fig. 268.—Pes Calcaneus.

resection of the talus may be necessary in very severe cases (Lund). In case of complete ankylosis of the joint, osteotomy may be called for, in addition to tenotomy (Billroth) or resection of the ankylosed joint after Velpeau's method. For

this purpose Reid [20] used the saw, but the operation is simpler when performed with the chisel and hammer.

Pes Calcaneus.—The reverse of pes equinus is the deformity known as pes calcaneus (*hakenfuss, pied bot calcanien*). The essence of this deformity is a contraction of the foot in a position of dorso-flexion. The patient walks on the heel and the sole of the foot is lifted upward (Fig. 267). The deformity is of common occurrence.

Nicoladoni [21] has critically analyzed this deformity. With him we may differentiate the following varieties: 1. The *pes calcaneum sursum flexus,* which is due to the flexion of the foot against the lower extremity and where the sole of the foot looks forward; 2. *Pes calcaneus* in a narrowed sense, where we deal mainly with a pure oblique position of the heel. The latter variety rarely depends on traumatism, but is usually paralytic. In paralysis of the muscles of the calf, the plantar muscles gain the ascendancy and pull the calcaneus forward and downward, the arch of the foot being thereby deepened. The first variety may either be congenital or acquired. The congenital form depends on intra-uterine disturbances, the feet, for instance, being maintained in a position of dorso-flexion. [Breech cases with extended limbs (Adams).]

FIG. 269.—Pes Calcaneus. (After Nicoladoni.)

Parker and Shattuck believe that the deformity first appears in the later months of gestation when the normal posture is one of flexion. Dorso-flexion may extend to such a degree that the entire dorsum of the foot may lie apposed to the lower extremity. According to the angle formed between the foot and leg, we may differentiate varying degrees of pes calcaneus. The congenital form is rarely pure, but usually complicated by valgus, forming the variety known as pes calcaneo-valgus.

The calcaneus sursum flexus may further be due to paralysis. Exceptionally the cause is pathological, as in a case reported by Kundrat, where there occurred displacement of the

epiphyses consecutive to osteomyelitis with central necrosis, or as in Mensel's case,[22] where a similar separation occurred spontaneously. Pes calcaneus, further, follows on traumatic causes, such as burns and subsequent cicatricial contraction or rupture of the tendo Achillis.

Reeves divides congenital pes calcaneus into three grades:

1. Where the angle between the foot and the lower extremity is normal, yet plantar-flexion is not possible;

2. Where the angle is an acute one;

3. Where the dorsum of the foot nearly or entirely rests against the anterior surface of the lower extremity.

Acquired pes calcaneus generally depends on paralysis of the muscles of the calf. Partially as the result of weight and

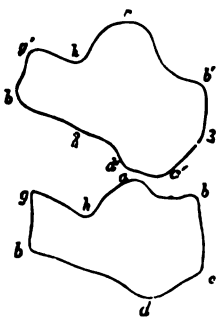


FIG. 270.—Schematic Sections of Calcaneus in Pes Calcaneus and in the Normal Condition. (Nicoladoni.) The line *b c*, the insertion of the Tendo Achillis, is bent at an angle in Pes Calcaneus.

FIG. 271.—Pes Calcaneus Apparatus with Elastic Traction.

partially owing to the action of the plantar muscles, the heel is drawn downward, it becomes more conical in shape, its position more vertical—pointing directly downward like the stump after Pirogoff's operation. The tendo Achillis can scarcely be felt, the anterior portion of the foot sinks down, and in the adult the arch of the foot is more or less deepened.

As regards the pathological anatomy of pes calcaneus,[23] only in adults do we find essential changes in form. Ordinarily the position alone is altered. In Nicoladoni's case (Fig. 270) the posterior portion of the calcaneus, near the talo-calcaneus joint, was bent downward, *a′ b′*. The tubercle of the calcaneus, which normally points downward and backward, may be lifted slightly forward, *c′ d′* (Fig. 270). The gastroc-

nemius, plantaris and soleus are usually atrophied, while the deeper muscles of the calf and of the sole are healthy.

The treatment of pes calcaneus aims at lifting the heel and depressing the apex of the foot. In the congenital variety in young children these indications are readily satisfied by fastening a cotton pad between the dorsum of the foot and the anterior surface of the lower extremity, or by correcting the malposition as much as possible and maintaining the foot in good position by a splint bandage. In many cases of burns of the dorsum of the foot and of the anterior surface of the leg, we must counteract the tendency to the formation of pes calcaneus by resorting to transplantations.

Pes calcaneus may be corrected after a very simple fashion by bandaging the foot to a splint which has a projection backward like a spur. This projection is connected by an elastic cord with a band or a strap above the knee.

As soon as the individual is able to walk, the question arises of a suitable calcaneus shoe. These shoes have a metal sole with a hooked projection backward. Two lateral bars extend to the knee and an elastic band is connected along the dorsum of the leg with the knee-strap and the hook of the projection from the sole (Fig. 271). In Kolbe's shoe an articular splint surrounds the leg a hand's breadth above the ankle, and an elastic band extends from it to a species of stirrup in the shoe, and this band counteracts the tension of the tendo Achillis.

Judson[24] has devised an apparatus for paralytic pes calcaneus, the essential part of which is a hinge in each lateral splint, at the level of the ankle joint, which allows of plantar flexion, but prevents the foot from dorso-flexing beyond a right angle. In walking and standing, then, the foot is maintained at a right angle to the lower extremity.

In simple cases of deformity, H. Bigg's apparatus[25] will suffice to restore the normal form to the foot. A splint, articulating at the ankle joint, is attached to the outside of a shoe and carries an S-shaped spring extending a trifle above the ankle down to an ivory roller. The heel is thereby lifted upward and the anterior muscles are stretched. Langgaard, in his apparatus, draws the shoe, and with it the foot, downward and backward by means of a circular spring attached to the leg splint and through the arm of a lever to a vertical projection from the shoe.

In severe instances of paralytic pes calcaneus, operative measures have been recommended. Albert, for instance, aims at obtaining artificial ankylosis of the ankle joint; Nicoladoni[26] advocates the section of the peronei behind the external malleolus and the union of their tendons with the severed tendo Achillis. Hacker[27] successfully accomplished this in a young girl of ten. Resection of the tendo Achillis and subsequent suture have a number of times been resorted to. Killet performed this operation through a V-shaped incision; Walsham,[28] in four patients with paralytic pes calcaneus, excised a piece from the tendo Achillis one half to three-fourths of an inch long through an oblique incision. He sutured the tendon with catgut, and in all the cases the deformity was bettered, in two complete cure resulting. Naturally, in case of fatty degeneration of the muscles of the calf, such measures are useless. The electrical reaction of the muscles must be tested beforehand.

In many instances, where the tension of the tendons on the dorsal surface is very great, tenotomy may be requisite. Where cicatrices are at the bottom of the deformity, these must be excised and the customary after-treatment be adopted. In very severe cases osteotomy of the inferior process of the calcaneus has been advocated.

In combination with pes calcaneus and pes equinus we frequently meet with pes cavus (*pied bot talus, hohlfuss*) which rarely occurs alone. This deformity consists in an excavation of the sole of the foot with an elevation of the arch. Usually the convexity of the dorsal surface is increased and this surface is shortened.

Pes cavus is rarely congenital and is then generally due to contracture of the plantar fascia. It is usually acquired (Fig. 272), being dependent upon muscular paralysis, especially of the gastrocnemii and the solei, whereby the heel sinks downward. In the Chinese woman this deformity is artificially produced by methodical compressive bandaging and by the peculiar shoes worn. The ligaments and muscles are not specially altered in this case, and the ultimate result is a hoof rather than a foot.

In Figs. 273, 274, typical instances of paralytic pes calcaneocavus are represented. The foot is shortened, abnormally bent, with dorsal surface sharply curved, and in profile the

sole appears nicked (Fig. 273). In the upright posture there is considerable space between the sole and the ground, and in

Fig. 272.—Paralytic Pes Cavus in a Girl of 14.

Fig. 273.—Paralytic Pes Cavus in a 20-year-old Student.

aggravated cases the individual walks only on the heel and the ends of the metatarsal bones. Callosities and ulcers often form and give rise to great pain and inability to walk.

In talipes plantaris, a number of the universal club-foot apparatuses to which we have referred may be used. One of the most useful appliances is that of Bigg (Fig. 275). It consists of a steel sole strapped to the

Fig. 274.—Foot of a Chinese from a Preparation in the Hunterian Museum.

Fig. 275.

foot and which may be straightened out by means of a screw.

By means of tenotomy, especially by section of the plantar

fascia and of the muscles of the sole of the foot, the treatment of pes cavus may be materially altered. Where the fascia may be felt as a tense band it must be incised subcutaneously.

Where we are not dealing with single tense bands, the muscles and fascia must be severed until the deformity can be corrected, as has been done in cases recorded by Schede and others, and the wound should then be treated antiseptically. We may thus assure a good result.

After tenotomy Bauer applies a boot with an iron heel and makes vertical pressure on the dorsum of the foot through the double screw which he has devised. He was thus enabled to cure a case of eighteen years' standing.

Pes planus (splay foot, *pied plat,* spurious valgus, *platte fuss*) must be sharply differentiated from flat foot (*plattfuss*) since in case of this deformity the relation between the navicular bone and the caput tali is not altered, while in pes valgus the head of the astragalus projects inward over the navicularis. In splay foot the most essential feature is the lack of arch to the sole and of the external curvature of the foot. Pronation is not present.

Fig. 276.

The foot of the new-born is always flat and we may consider pes planus the outcome of absence of that phase in growth which leads to the arching of the foot.

Pes planus is further characteristic of many African tribes. The Jews also have a splay foot. Relaxation of the ligaments, etc., is said to be a cause of pes planus.

The foot is markedly broadened and flat, without the projection of the head of the talus which is characteristic of valgus. The arching of the sole is lacking and the bones of the tarsus, as in case of valgus, rest on the ground. The pronation phenomena are wanting. Whether splay foot tends to become valgus, as some writers have claimed, or not is questionable. Treatment is usually not requisite. Occasionally elastic adjuvants are called for.

Some writers, Emmert [29] for example, differentiate the broad foot (*breitfuss*) (Fig. 276), where the anterior portion of the bones of the middle foot are broadened out from abnormal

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Pes Varus.—Under the term pes varus

Fig. 277.—Pes Varus in a Man of 23.

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Fig. 278.—Infantile Pes Varus.

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Pes varus is the most frequent of all the congenital deformities. Adams, in 764 cases of contracture of the foot, found the varus type 668 times; in 999 cases of non-congenital deformity, equino-varus occurred 162 times and pes varus 60 times. Out of 800 to 1000 men we may expect to find one instance of pes varus. The deformity affects most frequently males, it is ordinarily bilateral and when unilateral the right foot is implicated by preference (Roberts [30]), although Dieffenbach [31] claims the reverse.

We may differentiate a number of degrees of this deformity. It was formerly customary to make five divisions, but to-day the following three forms are differentiated:

1. Where the foot can still be brought into the normal position and the angle between the foot and the lower extremity is greater than 90°;

2. Where correction is not possible to such a degree, the foot being drawn more internally. There then exists contracture of the tendons and fascia;

3. Where it is impossible to correct the deformity manually, the foot being at an acute angle with the inner surface of the lower extremity, all the tissues on the inner side being shortened.

Fig. 279.—Paralytic Pes Varus in an Early Stage. Young Girl of 9.

A division, according to etiology, into congenital and into acquired pes varus is preferable. In the congenital variety, the deformity is due to a primary change in the bones, in the acquired form the causal factor, in general, lies outside of the bones, the majority of cases being dependent on paralysis, either peripheral or central, and this, secondarily, leads to deformity of the bones. The cause is rarely to be sought in spastic or inflammatory conditions or in trauma which has left lasting changes in the bones or the joints of the foot and lower extremity (the traumatic pes varus).

Congenital pes varus depends on abnormal shape and position of the separate bones of the foot and of the joints, and various explanations have been offered as to the cause of the

deformity. Esricht[32] considered the defo
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FIG. 280.—Infantile Pes Varus, the Talus being Exposed.

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In the talus there is a constant characteristic deformity, its neck being lengthened in an oblique direction inward (*vide* Fig. 280).

While in the new-born the normal obliquity of the talus is 38°, that is to say, the sagittal axis of the talus forms an angle of 38° with a line drawn parallel with its external border (Fig. 282), and while in the adult this angle only amounts to 10.65°, in case of congenital pes varus the angle is 49.6°, the maximum being 64°, and, in consequence, as Parker has shown, the talus bears a strong resemblance to that of the ape, in whom the foot possesses great range of motion in the sense of inversion and of supination.

FIG. 282. — Talus from an 18-months-old Child with Pes Varus. (Parker.)

The whole body of the talus is flattened. It is sharply cut off backward like a wedge and, as a rule, it is flexed on the plantar surface of the foot. The talo-crural joint has lost the character of a hinge-joint and approximates that of an amphiarthrosis. The trochlear surface projects backward nearly or entirely to the posterior border of the lower joint surface; anteriorly this surface is worn down, the internal articular facet is scarcely recognizable, and that which articulates with the external malleolus is pushed forward. The head of the talus is directed a trifle downward, forming an angle of 65° with the axis of the talus, instead of one of 45° as in the new-born.

FIG. 283.—*a*, The Calcaneus, Pes Varus at One Year; *b*, the Calcaneus, Normal, in the New-born; *c*, the Calcaneus, Pes Varus in the New-born.

The articular surface of the head of the talus points inward and occasionally it is divided into two apposed facets, of which the internal alone is in contact with the navicular bone, the other being only covered with a thin layer of cartilage and by the elongated ligaments.

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length of the transverse ligaments. The function of the foot is not affected. This condition may coexist with splay foot.

Pes Varus.—Under the term pes varus (*Klumpfuss, pied*

FIG. 277.—Pes Varus in a Man of 23.

bot varus, supination contracture, adduction contracture) is understood that deformity where the foot deviates inward from its longitudinal axis, is supinated and usually adducted. The apex of the foot is directed inward, the sole is curved inward, the internal border of the foot is lifted from the ground and the external border is depressed (Fig. 277).

FIG. 278.—Infantile Pes Varus.

As a rule, the talo-tarsal joint is not alone implicated, but the talo-crural joint as well. The foot is plantar-flexed, that is to say, its apex is sunken, forming a pes equino-varus, not a pure pes varus. To this deformity Henke gave the name of pes flexus adductus-inflexus.

In all small children there exists a tendency to the varus position of the foot, and we may say that this is the normal position in the fetus and that later, as a result of the at-

tempts at walking, etc., the varus changes into the normal position.

Pes varus is the most frequent of all the congenital deformities. Adams, in 764 cases of contracture of the foot, found the varus type 668 times; in 999 cases of non-congenital deformity, equino-varus occurred 162 times and pes varus 60 times. Out of 800 to 1000 men we may expect to find one instance of pes varus. The deformity affects most frequently males, it is ordinarily bilateral and when unilateral the right foot is implicated by preference (Roberts [30]), although Dieffenbach [31] claims the reverse.

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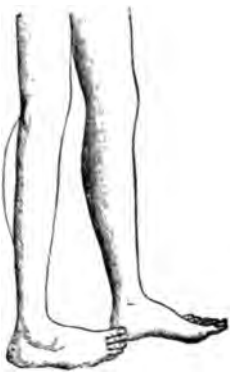

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Congenital pes varus depends on abnormal shape and position of the separate bones of the foot and of the joints, and various explanations have been offered as to the cause of the

deformity. Esricht[32] considered the deformity the result of a persistence of the curvature of the foot which normally exists at a certain stage of fetal development; others believe it due to abnormal position of the fœtus *in utero*, claiming that the bones and joints of the foot, being subjected to pressure, are forced to maintain the varus position, and that this in the course of fetal development becomes exaggerated (Kocher[33]). This pressure is not always due to the fact alone that the liquor amnii is deficient in amount, for in a case recorded by Kocher the deformity existed in a very early period of fetal life. Indeed, the observations of Lücke, Volkmann, Kocher, Parker,[34] and Roser render it doubtful if Martin's view in regard to the effect of uterine pressure be correct. In many

FIG. 280.—Infantile Pes Varus, the Talus being Exposed.

FIG. 281.—Talus of the Normal Adult.

instances it seems that pes varus may develop in the later stages of pregnancy. Parker and Shattuck have found the caput tali divided into two apposed facets, the one of which had degenerated from the fact that it had not been used, and this would seem to point to extensive capacity for motion of the feet in early fetal life.

As regards the anatomical changes[35] in congenital pes varus, Adams and Hüter[36] have shown that there exists essential abnormity in the configuration of the bones, an exaggeration in the fœtus, as it were, of the form of the bones and joints met with in the adult.[37] Kocher, in particular, has shown that not only are the talus and the calcaneus implicated, but that all the bones of the tarsal joint take part in the changes which are characteristic of congenital pes varus.

On considering these congenital alterations, we find not only the bones and joint surface altered, but also, not infrequently, abnormal changes in the lower and even in the upper extremity.

In the talus there is a constant characteristic deformity, its neck being lengthened in an oblique direction inward (*vide* Fig. 280).

While in the new-born the normal obliquity of the talus is 38°, that is to say, the sagittal axis of the talus forms an angle of 38° with a line drawn parallel with its external border (Fig. 282), and while in the adult this angle only amounts to 10.65°, in case of congenital pes varus the angle is 49.6°, the maximum being 64°, and, in consequence, as Parker has shown, the talus bears a strong resemblance to that of the ape, in whom the foot possesses great range of motion in the sense of inversion and of supination.

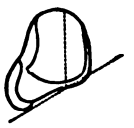


Fig. 282. — Talus from an 18-months-old Child with Pes Varus. (Parker.)

The whole body of the talus is flattened. It is sharply cut off backward like a wedge and, as a rule, it is flexed on the plantar surface of the foot. The talo-crural joint has lost the character of a hinge-joint and approximates that of an amphiarthrosis. The trochlear surface projects backward nearly or entirely to the posterior border of the lower joint surface; anteriorly this surface is worn down, the internal articular facet is scarcely recognizable, and that which articulates with the external malleolus is pushed forward. The head of the talus is directed a trifle downward, forming an angle of 65° with the axis of the talus, instead of one of 45° as in the new-born.

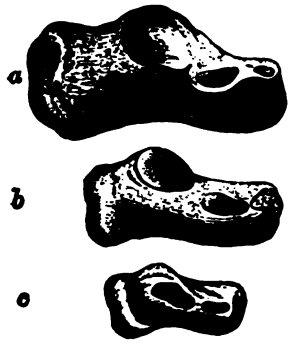


Fig. 283.—*a*, The Calcaneus, Pes Varus at One Year; *b*, the Calcaneus, Normal, in the New-born; *c*, the Calcaneus, Pes Varus in the New-born.

The articular surface of the head of the talus points inward and occasionally it is divided into two apposed facets, of which the internal alone is in contact with the navicular bone, the other being only covered with a thin layer of cartilage and by the elongated ligaments.

The calcaneus (Fig. 283) is sharply rotated internally under the talus, its tuberosity is directed toward the fibula,

and the abnormal height of its anterior process is especially striking, as also the oblique slanting of the upper joint-surface. The sustentaculum tali—the apparatus which checks supination (Hüter) and which in the new-born is much deeper than in the adult—is lacking. The articular surface for the cuboid is situated on the median side and the longitudinal axis of the calcaneus is curved so as to be concave internally and the anterior process and tubercle of the bone point inward.

The cuboid, seen from above, is quadrilateral rather than triangular in shape, and this is due to the increased lateral growth where the effects of pressure are wanting. The navicular bone lies to the inner side of the caput tali and the longitudinal axes of these bones are rather parallel than at a right angle.

The lower extremity is frequently twisted inward at its lower portion, and the end of the fibula projects forward.

FIG. 284.—The Cuboid. 1, Normal at Two Years; 2, Pes Varus (One Year).

FIG. 285.—Pes Varus in an Adult.

The ligaments are altered in accordance with the change in position and in form of the bones. The internal lateral, the plantar, calcaneo-fibular and talo-navicular ligaments are shortened, and the external ligaments are stretched.

The muscles retain their normal relations. Even after section of the muscles and ligaments, entire reposition is not possible. The tendons are altered in their relation to the bones. The tendon of the peroneus longus, for instance, forms a groove on the external and under surface of the calcaneus. In a single instance Roser found a sesamoid bone in the tendon of the tibialis posticus, in its course between the internal malleolus and the first cuneiform bone. Similar changes, in the main, are found in all cases of pes varus in infants, and the feet are in a position of supination. We refer, in this connection, to Kocher's description of pes varus in

infants of one year and of three. The soles of the feet may be approximated like cymbals.

The anatomical changes in congenital pes varus of adults are of a still higher degree than in children, and they are marked especially by the formation of new and abnormal facets. The internal malleolus is less prominent, shorter and rounder,

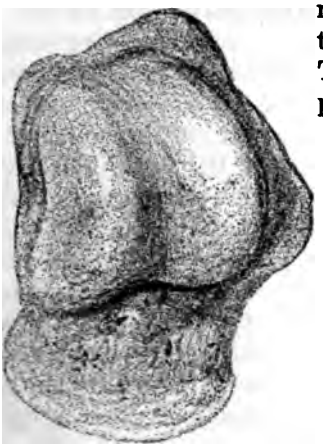


Fig. 286.—Talus of an Adult.

Fig 287.—Talus of an Adult with Pes Varus.

and a joint is often found between it and the navicular or even the cuneiform bones. The groove for the tendon of the tibialis posticus is very shallow. The bones are not of normal size and thickness, but they are rather osteoporotic and fatty, and the two posterior bones of the foot are most markedly altered.

The talus is more slender and longer, the trochlea is, posteriorly, only partially covered with cartilage and, anteriorly, it is divided by a transverse line (Fig. 288). The lateral joint surfaces are unequal. That for the fibula is sharply pushed forward against the neck of the talus, it is larger and, at the posterior border of the trochlear articular surface, it is divided into a triangular surface. The articular surface for the tibia is generally very small. The caput tali is ill-developed, misshapen, and frequently carries two facets, of which the external is not covered by cartilage and the internal articulates with the navicular bone (Fig. 288).

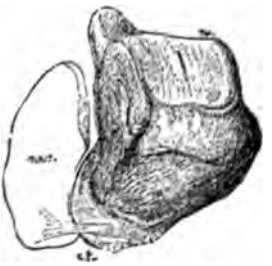


Fig. 288.—Pes Varus Sinistr. The Talus and Scaphoid. (Adams.)

The calcaneus is altered in shape and position; its longitudinal axis is curved with median concavity; its upper articular surface is flattened in the centre and so sharply pushed inward that it does not reach the eminence of the bone (supination position). The anterior portion is longer and higher and springs forward a trifle. The tuberosity projects upward and lies just behind the fibula. The upper surface of the calcaneus lies in contact with the posterior border of the articular surface of the tibia, so that in severe cases the os calcis seems to belong to the joint of the foot. The articular surface for the cuboid may be displaced entirely toward the centre.

The navicularis is also altered in form and in position. It is shaped like a double wedge, the central portion having a lesser sagittal diameter and being flattened like a wedge downward. The bone is frequently displaced under the internal malleolus and, as a rule, articulates with it by a facet, as though it had been drawn into the assumed position by the action of the tibialis posticus.

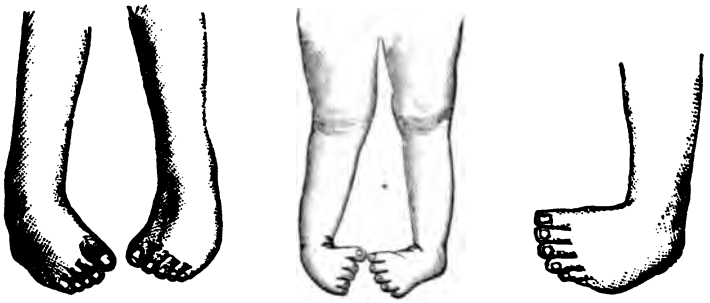
The cuboid is displaced to the same extent inward; it overlaps two-thirds of the articular surface of the calcaneus and is connected with it by the stretched ligaments. Its transverse diameter is ordinarily increased, is more quadrilateral in shape, its external surface is more convex. In a case observed by Noble Smith, the enlargement of the cuboid seemed to be the chief cause of the deformity.

The cuneiform bones are directed from above backward. They are not vertical and are more behind than near one another. The ligaments and the tendons are adjusted to the changes in the bones. Roser[88] found a sesamoid bone in the tendon of the tibialis posticus where it extends between the internal malleolus and the first cuneiform bone.

In regard to the external appearances of congenital infantile pes varus (Figs. 289–291), the tarsal joint is bent inward and shortened, the anterior portion of the foot is directed more to the front and the sole more backward; the internal border of the foot looks upward and the external downward; the heel appears very small and frequently assumes an almost vertical position. The internal malleolus is not as prominent, the external projects markedly.

In very aggravated cases, the angle formed between the

foot and the lower extremity is an acute one; the longitudinal axis of the foot lies more to the front; occasionally the foot is shortened and there exists a deep transverse depression in the sole, due to rigid contracture of the plantar fascia.



FIGS. 289, 290 and 291.—Various Grades of Infantile Pes Varus.

As we have stated, as the result of the action of weight the form of the foot is essentially changed. Since this action is not on the arch of the foot but on its external border, and the foot, in consequence, becomes greatly supinated, the individual soon walks on the dorsum of the foot.

When we meet in the adult with pes varus which has not been subjected to suitable treatment, the foot, in aggravated

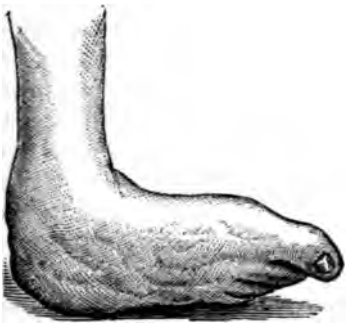


FIG. 292.—Congenital Pes Varus in a Man of 26

FIG. 293.—The Same, Seen Posteriorly. (Adams.)

instances, looks like a club; the sole points upward and backward, the dorsum forward and downward; the decrease in length is the outcome of atrophy; the heel, which is drawn upward, is small, the skin tense; on the dorsum of the foot a

thick club-like callosity has developed, the subcutaneous cellular tissue being infiltrated and containing a bursa (Figs. 277, 294).

The anterior and posterior portions of the sole of the foot are separated by a deep transverse groove; a second longitudinal groove divides the sole into two halves (Fig. 293), and these grooves are characteristic of congenital pes varus, for they are not marked or are entirely absent in the acquired form (Adams).

As a result of the great atrophy of the muscles, the calf of the leg is effaced, the limb looking like a cylindrical stilt. The length of the extremity is occasionally diminished, and the appearance suggests the leg of an animal, whence the popular names "cow-foot" "devil's foot," etc.

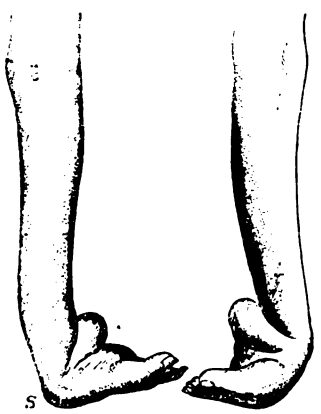


Fig. 294.—Pes Varus in a Man of 30.

In severe instances, not only is the foot, but the lower extremity, the knee, and upper extremity are also turned inward, and in order to make measurements it is necessary to remember that the patient masks in part the inward rotation of the lower extremity by an outward rotation of the femur. "The real inward rotation is, as a rule, much greater than the apparent" (J. Wolff) and, in order to determine it, the legs must be placed with the patella exactly in front, or, when the individual is recumbent, looking directly upward. Thus this rotation is eliminated.

Acquired pes varus may be the outcome of a number of causes:

1. Disturbances of the nerves, unequal muscular traction; 2. Traumatism.

The majority of instances of acquired varus are certainly paralytic, the sequela of infantile paralysis of central origin, and, ordinarily, pressure, etc., leads to the formation of an equino-varus. In its inception we are not dealing, as in congenital varus, with a primarily deformed foot, but only with a certain degree of deviation from the normal shape. As the result of use of the foot, the acquired pes varus assumes simi-

lar appearances to the congenital. Less frequently the acquired variety may be traced to spasmodic affections, such as contraction of the supinators. An instance of this is the acquired pes varus hystericus.

Traumatism may lead to pes varus through unequal muscular traction. Thus, an injury to the peroneal nerve may cause paralysis of the pronator muscles, and, in consequence, the supinators obtain control over the foot. In the majority of instances of traumatic varus, the cause is to be found in direct changes in the affected bones, as, for example, dislocations of the tarsal joints, fractures of the tibia, of the internal malleolus, of the talus, etc. Diseases of the bones, in particular partial necrosis, may result in varus. Bartels has reported an instance following on osteomyelitis and sequestrotomy. Cicatricial contraction from burns on the inner side of the ankle-joint is a rare cause.

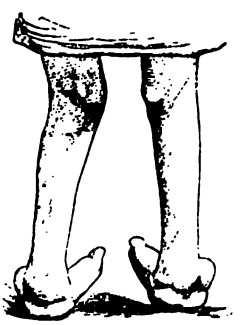


Fig. 295.—Aggravated Pes Varus.

The anatomical changes differ greatly according to the degree of the varus. As a rule, we find arrested growth and an atrophy affecting all the tissues. Essential deformity of special bones is less marked than in the congenital form. The talus, especially, retains to a greater or less degree its normal shape, the calcaneus its sagittal direction. The alterations are chiefly in the joints, leading to the so-called subluxations.

The atrophy of the muscles and of the tendons is quite marked. The external appearances of acquired pes varus are less characteristic than those of the congenital form. The general atrophy, especially in the paralytic forms, is striking (Fig. 279). The lower extremity resembles a thin stick. The bony projections on the dorsum of the foot and the depressions on the plantar surface are lacking. As a rule, the deformity is not a rigid one. In paralytic cases the livid color and the coolness of the entire extremity are striking.

As for the influence of pes varus on the individual, Dieffenbach has said, with truth, that the deformity is a greater affliction than the loss of a limb. From early childhood to the grave it is a lasting source of bitter complaint. The individual considers it a disgrace to have been thus brought into the

world. According to the degree of the deformity, locomotion is more or less interfered with; in bilateral instances, where in walking the toes are in contact, the individual progresses as though he were on stilts. The deformity cannot be concealed by the most expertly constructed shoe, and these, usually, resemble a hoof (Fig. 296).

The difficulty in locomotion often causes these individuals to resort to work which may be accomplished in the sitting posture (tailors, etc.). Dieffenbach has pointed out that many patients on being cured seek more active occupations.

The special diagnosis of the individual form depends on the appearance of the posterior segment of the tarsus, on the relation of the heel to the malleoli, on the distance of the apex of the external malleolus from the plantar surface of the calcaneus.

Fig. 296.—Congenital Pes Varus.

The clinical course of congenital pes varus is the following: With the first attempts at walking the external border of the foot alone touches the ground. The downward weight does not, as is normal, cause increased pronation, but supination of the foot. Gradually the dorsal surface serves the purpose of locomotion, and as development increases, this perverse tendency is exaggerated, the ligaments and the muscles adjusting themselves to the abnormal relation of the bones.

On the dorsal surface of the foot callosities and subcutaneous bursæ form, particularly over the projecting anterior process of the calcaneus. Not infrequently these bursæ become inflamed and suppurate, thus adding to the suffering of the unfortunate individual.

The muscles of the foot and of the lower extremity, which are not used by the club-footed in walking, gradually atrophy, even though at birth they were normal, and thus, at the outset, unequal muscular traction is at work—a factor which in case of unilateral pes varus is especially marked in the calf (Fig. 339); at times a marked shortening of the affected limb may be determined.

The therapeutic indication in case of pes varus is to convert the supination position into that of pronation. Formerly

it was the custom to defer treatment of congenital varus until the child was a year or more old. Unquestionably it is wiser to resort to treatment as early as possible, even in the first week of the child's life, particularly since J. Wolff has shown that the child's foot grows very rapidly during the first months of its existence, and that therefore the elements which interfere with correction concomitantly increase. This view is in accord with that of Albert, Kocher, König, Margary, Mensel, Sayre, Vogt, and others.

In the new-born, of course, it cannot be a question of complicated apparatus and bandages. We may attain our aim by means of suitable manipulations, traction into the normal position, that is of pronation and dorsal flexion, especially

Fig. 297.—Manual Correction of Pes Varus.

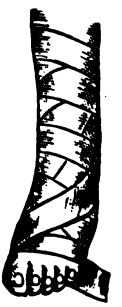


Fig. 298.—Correction by Bandage.

when, in addition, we maintain the obtained result by small splints. Thus, in a few weeks, an aggravated club-foot may be almost entirely cured.

The manipulations should be resorted to frequently and the mother may readily be taught to perform them. The lower extremity should be steadied by one hand and the other should grasp the foot and endeavor to carry it into a position of pronation and of dorso-flexion and to maintain it in such position for a few minutes (Fig. 297).

During the night, and occasionally during the day, the foot should be held by a small splint and bandage in a position as much opposed to the faulty one as possible. Splints of various material, sticking plaster, and the ordinary bandages are at our disposal for this purpose (Fig. 298).

In Mellet's "Manual" there are tabulated 150 cases of pes varus cured by manipulation and bandages.

Formerly it was customary to treat congenital club-foot in two stages: First to convert the varus into an equinus by

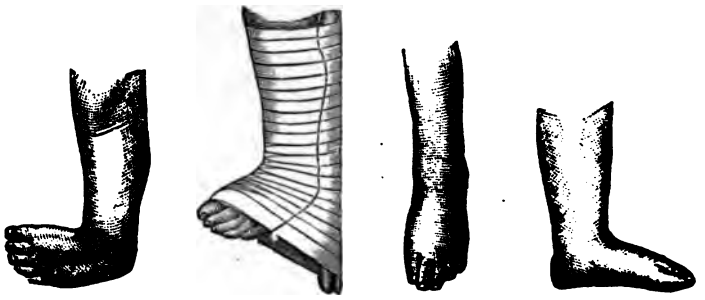


FIG. 299. FIG. 300. FIG. 301. FIG. 302.
Treatment of Pes Varus in Two Stages. (After Adams.)

means of an external wooden-splint to which the foot was bandaged (Fig. 300), and next to restore the foot to the normal by tenotomy (Fig. 302).

In Fig. 300 is shown the application of the splint to the foot and in Fig. 302 the result. Adams[39] recommends a simple, infantile varus splint which consists of a splint for the upper extremity, of one for the lower with a joint at the knee, of a foot-piece provided with an endless-screw mechanism.

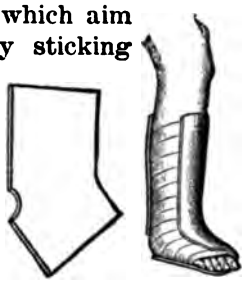
FIG. 303. FIG. 304. FIG. 305. FIG. 306.
Vogt's Club-foot Felt Splint.

Splints constructed of the following materials may be used: metal, pasteboard, leather (Paraeus, MacEwen), silicate of soda and pasteboard (Vogt), rubber (Lorinser). Felt splints

are, after pasteboard, the best, and the relatives of the little patient should be instructed how to apply them. In the infant, splints and manipulations are the chief means of treatment, for permanent bandages cannot be utilized owing to the fact that they become so quickly soiled. When the foot has been placed in the desired position, the parents may be taught to apply the felt splint, and the case, therefore, does not require the constant supervision of the physician.

Vogt shapes the felt as is represented in Fig. 303, forming a posterior splint and two overlapping portions which make the foot-piece. König prefers an internal lateral splint modelled as is represented in Fig. 307 and applied as in Fig. 308. The foot is maintained in correct position by means of a roller flannel bandage.

When the skin of the foot has become less tender, that is to say, in older children, then the methods which aim at elastic traction by sticking plaster and the permanent bandages are applicable. Strong plaster (Maws' moleskin is the best) should be cut into strips about one and one-half inches wide and bound around the foot and leg, drawing the former into a position of pronation. Fischer, Sayre, Mensel, and others, have recommended this method.



Figs. 307 and 308.—Felt Splint. (After König.)

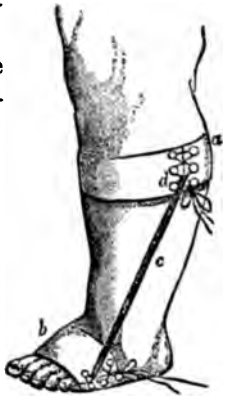


Fig. 309.—Elastic Traction. (After Willard.)

Sayre carries the plaster strip as high as the head of the fibula, places a roller bandage over it, and, when he desires greater traction, he surrounds the bandage by a second strip. Mensel[40] envelops the foot in three layers of moist gauze, and, after this has dried sufficiently, he applies strips of plaster in such a way as to keep the foot pronated. Barwell has efficiently combined elastic traction with the application of moleskin plaster (*vide* Figs. 244–246). Forest Willard carries strips of cambric, one and three-fourths to three inches wide, around the leg and foot (Figs. 309, *a*, *b*) and connects them by an elastic band. Sticking plaster may, obviously, be also used

in combination with silicate of soda, plaster-of-Paris, etc., bandages.

When the child has reached the age of walking, retention apparatus is, as a rule, resorted to. The aim of apparatus of this nature is to prevent recurrence of supination of the foot. Felt splints have the advantage that they may be worn under the clothing. Club-foot shoes, of which we will speak in detail later, answer the purpose of keeping the foot pronated. In its simplest form such a shoe consists of a laced boot carrying a flexible bar, with slightly outward spring, articulating at the level of the ankle-joint. We must emphasize the fact, however, that club-foot shoes should not be used too early, lest recurrence of the deformity set in.

In case of still older children, apparatus which acts by elastic pressure and traction may be used. In this way gradual correction of the deformity may be attained (*redressement continué*), or else correction may be reached at one sitting (*redressement forcé*). Formerly the plaster-of-Paris bandage was used almost exclusively in the treatment of pes varus. The foot was placed in as correct a position as possible in a plaster bandage; at the end of from one to two weeks this bandage was removed, the deformity still further corrected and a second bandage was applied, and so on until the normal position was acquired. The case was considered cured when the foot remained in normal position without being held there and when, in ascending the stairs and in walking, the sole of the foot rested entirely on the ground. Hahn uses a simple means for holding the foot in position whilst the plaster bandage is being applied, and yet not interfering with the operator. This is a T-shaped wooden splint (Fig. 310) which is set in the bandage. Upward traction at *a* and at *d* overcome the equinus and inversion position. In small children, to prevent the bandage becoming soiled by the urine, it is advisable to varnish it and to bind its upper edge with sticking-plaster. Inward rotation must, as far as is possible, be guarded against, and such a tendency may be overcome by tying the feet together and, at night, by fastening a wedge-shaped cushion between them.

The objection to the plaster bandage, that it interferes with active and passive movements, does not hold, for the bandage is changed every eight to fourteen days, when an

opportunity is given for bettering the position of the foot by means of passive manipulations.

For many reasons it is important that the patient should soon be enabled to walk around, and the ambulant apparatuses are, therefore, of great utility. In order to prevent inward tilting of the feet in walking, Roser has recommended a stirrup-shoe, that is to say a shoe provided with an ⊓-shaped stirrup projecting about one inch beyond the sole.

In older children and in adults, the indications for the treatment of club-foot differ somewhat. J. Wolff, in particular, has resorted to redressement in stages by means of ambulant apparatus. He first applies three to four strips of adhesive

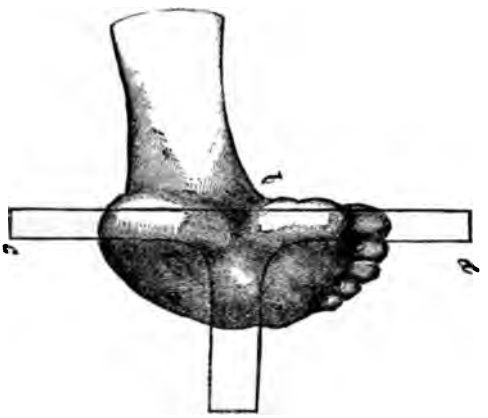


FIG. 310.—Hahn's T-Shaped Splint.

plaster, after Sayre's method, over this a moist bandage, next a silicate-of-soda bandage, and, over all, a provisional plaster bandage, the foot being held in as correct position as possible while this bandage is setting. After the lapse of a few days, the plaster bandage is removed, a second silicate of soda bandage is applied, and over this an ordinary stocking and shoe are worn.

According to Wolff, it is peculiarly important that the patient should walk on the sole of the foot, that is, that the foot should functionate in normal position, for thus the normal architectural structure of the foot will be regained. Such should be the aim of every method of treatment of club-foot. After very forcible reduction (at times after tenotomy, etc.)

the silicate-of-soda bandage should be applied and should be worn for seven to nine months. In severe instances of congenital club-foot, betterment of position is attained at the very outset by cutting a wedge-shaped piece out of the bandage, correcting the position still further, and strengthening the bandage by a second application of the silicate. It may require, therefore, eight to twelve days for the completion of the bandage.

We will now consider forcible redressement of pes varus under anesthesia (König, Wolff) with after-treatment by a retention bandage. With the exception of very young children and of adults with very compact bones, this method is suitable for the majority of cases of club-foot, congenital as well as paralytic, especially in the developmental stage. König operates as follows: The projecting external side of the foot, at the point of articulation of the calcaneus with the cuboid and the lateral border of the talus, is placed against a hard surface. An assistant or one hand of the operator presses the heel firmly against the surface, and the operator, taking purchase on the inner side of the portion of the foot which projects over the fulcrum, corrects the deformity by the weight of his body. This, as a rule, requires two to three séances. The foot is then surrounded by a plaster bandage in order to secure the result, and, where the force resorted to has been great, the foot is suspended vertically. This forcible redressement results in rupture of ligaments, in fracture of fragments of the bone from the concavity, and in splintering of the bone in the convexity. König prefers this method to operations with the knife, seeing that, in his experience, it has been followed by better shape and function of the foot.

Instrumental forcible reduction has also been resorted to and has been recommended particularly for instances of rigid club-foot in older children and in adults. Velpeau, Morton, and others have devised apparatus in which screw pressure is utilized to redress the foot. In Fig. 311 is represented the apparatus devised by Kolbe, of Philadelphia. The apparatus consists of a block of wood carrying a padded horse-shoe for the fixation of the heel. The foot is strapped to this block as is represented in Fig. 311. The adduction is overcome by the outward traction exerted through the screws on the eminence of the tarsus and of the great toe, while movements of the block will effect flexion and eversion.

Bradford[41] uses an apparatus provided with padded cushions for the purpose of forcible reduction. Two cushions are applied on the inner side of the foot over the calcaneus and the metatarso-phalangeal joint, and a third on the outer side a little in front of the external malleolus. These cushions are held in position by means of screws, and by means of a fixed rod in the foot-piece forcible pronation, supination, plantar and dorsal flexion are possible. Bradford, as a rule, resorts to this apparatus after he has tenotomized the tendo Achillis and the plantar fascia.

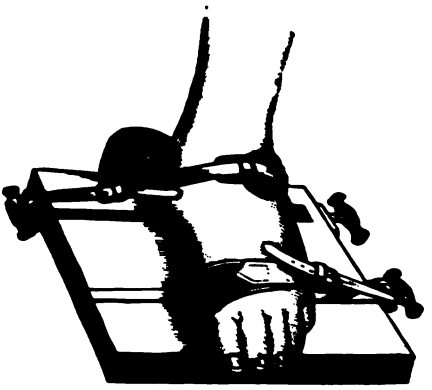


Fig. 311.—Kolbe's Traction Apparatus.

More gradual forcible redressement may be affected through Stillman's[42] club-foot twister, which is represented in and readily understood from Fig. 312.

Before I proceed to speak of the operative measures, I must refer to the various club-foot machines, which, as a rule, are provided with lever- and screw-mechanism, elastic traction means, etc. These machines are only suitable for patients who come under treatment in late childhood. They cannot be used during the early years of life, for then they are ill-adapted to the little feet, readily become inefficient, and may excoriate the foot or induce gangrene from pressure.

Fig. 312.—Stillman's Apparatus.

Fig. 313.—Venel's Sabot.

In general, apparatus of this nature is only suitable for the second stage of treatment. In the application, great care must be exercised that the foot

rest thoroughly on the sole and that the splint for the lower extremity is exactly adapted. Ordinarily, apparatus of this nature is provided with means for dorsal flexion, pronation, and abduction of the foot, and also with a device for lifting the external border of the foot, similar to that in Venel's "sabot" which consists of a wooden foot-piece and a lever bar extending along the external surface of the lower extremity (Fig. 313). V. Bruns[43] has modified this simple apparatus by fastening the foot by a number of straps passing through holes in the foot-

Fig. 314.—Little's Apparatus

Fig. 315.—Stromeyer's Club-foot Shoe.

Fig. 316.—The Same, Applied.

piece, and by making elastic traction on the foot by means of rubber tubing extending from the foot-piece along the outside of the extremity to the knee. In this manner the foot is pronated.

The well-known Scarpa's shoe is the type of the sandal-formed club-foot shoes which have been devised by Scoutetten, Delpech, Guérin, Blasius, Günther, Schuh, Martin, and others. These shoes differ, however, in many respects from the original Scarpa model. One of the best known of the many modifications of the Scarpa shoe is Little's. The mechanism in this shoe effectually overcomes the equinus position

and prevents plantar flexion, while offering no obstacle to dorso-flexion (Fig. 314). Stromeyer modified the Scarpa shoe by making the anterior portion of the sole movable, and by attaching the screw, *c*, which allows of the external splint, *a*, being placed in the desired position. The spring, *b*, on the outside of the shoe effects inversion of the foot (Figs. 315 and 316).

Tamplin's modification, as used at the London Orthopedic Hospital, consists of an iron sole, *a*, covered with leather; of a heel-piece, *b*; of an external lateral splint, *c*, attached to the lower extremity by the strap, *d*. The external spring, *h*, everts the foot; the straps, *e* and *f*, maintain the heel in correct

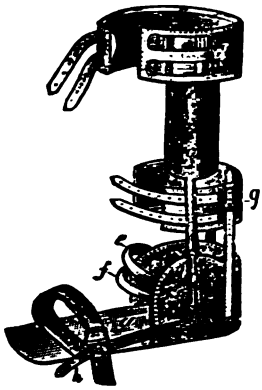


Fig. 317.—Tamplin's Apparatus.

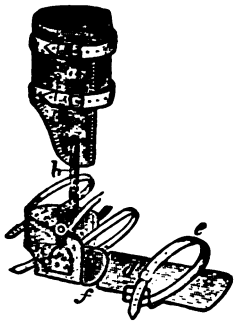


Fig. 318.—Adams' Apparatus.

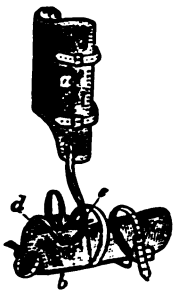


Fig. 319.—Langgaard's Apparatus.

position; the strap, *g*, serves the purpose of fixing the apparatus firmly above the ankle. Flexion and extension are regulated by the screw, *k*, and inversion (eversion) by the screw, *l* (Fig. 317). In Adam's[44] modification the strap, *e*, draws the foot outwards; flexion and extension are obtained by the screw, *c* (Fig. 318). In a later model, in which there is more direct action on the anterior part of the foot without the exercise of lateral pressure, Adams inserted three joints controlled by screws, one at the ankle-joint, a second at the transverse tarsal joint, a third at the tarso-metatarsal joint. Leather straps encircle the upper and lower extremities, and the splint is jointed at the level of the knee.

In Ebner's and in Langgaard's (Fig. 319) apparatus, the sole, *c*, is also movable on the heel-piece, *b*. In Ebner's appa-

ratus there is a pad which exerts pressure on the convexity of the foot; in Langgaard's, an endless-screw, *d*, controls inversion and eversion. In the Sutter-Langenbeck sandal-shaped club-foot shoe, the equinus position is overcome through a screw, and the foot may be pronated and supinated at will by

Fig. 320.—Kolbe's Club-foot Shoe, for the Left Side.

Figs. 321 and 322.—Kolbe's Club-foot Shoes.

means of an endless screw in the lower extremity splint. In Kolbe's apparatus, lateral splints, jointed at the knee and carrying rings, are used for fixation; correction is accomplished

Fig. 323.—Bardenheuer's Club-foot Shoe.

Fig. 324.—Sayre's Shoe.

Fig. 325.—Klopsch's Shoe.

by means of turn-screws, and abduction of the anterior portion of the foot is prevented by a strap carried over the metatarsal joint.

In Nélaton's apparatus, the foot may be brought into any

desired position and it may be gradually redressed. In the Robert-Collin's apparatus and in the Heather-Bigg, the mechanism for correction of the deformity is posterior. In Busch's apparatus, the lower extremity is incased in leather; two lateral-splints are united behind the ankle-joint by a nut-joint (enarthrosis) which secures dorso-flexion and pronation, while a second joint of a similar nature in the sole permits abduction of the apex of the foot. Bardenheuer's[45] club-foot shoe (Fig. 323) allows of outward traction and prevents inward rotation, while dorso-flexion is possible and plantar flexion is overcome.

In general, club-foot shoes fitted with screw, etc., mechan-

Fig. 326.—Willard's Shoe.

Fig. 327.—Blanc's Apparatus.

ism are to-day less in favor, for the reason that the advantage which they possess of enabling us to maintain the foot in the desired position is counterbalanced by the disadvantage that the great pressure exerted may lead to gangrene. These shoes should be used with great caution and be carefully supervised. In many cases, especially in the paralytic variety, apparatus provided with means for elastic traction is to be preferred. In addition to Sayre's apparatus (Fig. 324), we would refer, in this connection, to Blanc's (Fig. 327), where rubber rings supply a continuous correcting force, the foot being effectively pronated and the tendency to plantar flexion being opposed. The mechanism is apparent from the figure.

The majority of club-foot appliances ar after the chief deformity has been overco bandage, etc. They enable the patient to thus further act as correcting agents.

In Willard's apparatus the heel and m of the sole are united by soft leather, and (Fig. 326), passing through the opening, *a*, overcomes adduction of the foot. Stillman method of elastic traction to an apparatus

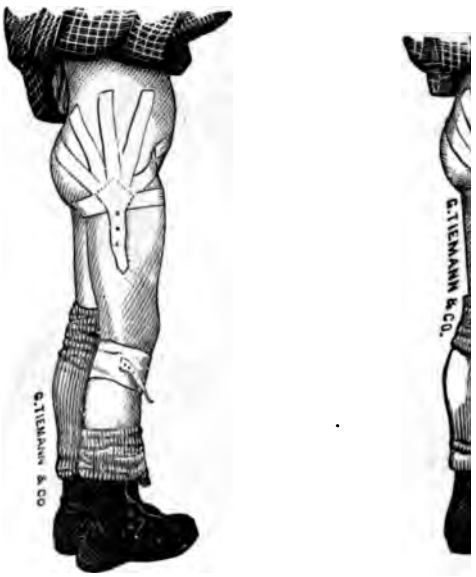


FIG. 328—Stillman's Club-foot Shoe.

with any form of shoe (Fig. 247). The hin ankle-joint increases the action of the el Stillman's apparatus abduction is acquire position is corrected by means of elastic ba To prevent rotation of the apparatus on necessary to attach it to the lower and by strips of adhesive plaster. Beely, Kolb devised shoes which act on a similar prin apparatus (*vide* Fig. 331).

Stillman also endeavored, by means of at the ankle-joint, to counteract the tend

rotate inward. In Fig. 329 the spring blade when fastened to the lower extremity tends to pronate the foot. In older children and in adults, in order to complete the cure, it is essential to accustom the joint to maintain the pronated position. With this end in view, manipulations which suggest themselves are useful.

In order to prevent inward rotation of the extremity, that is, in order to favor outward rotation, in the less aggravated instances it suffices to prolong the apparatus as high as the groin and to attach it to the pelvis by a strap or to the thigh by adhesive plaster (Fig. 328). Bruns resorts to elastic traction (Fig. 332), attaching a rubber cord to the upper end of the external blade of the apparatus. This band crosses the thigh posteriorly and is fixed to a pel-

Fig. 329.—Stillman's Pulling Spring.

Fig. 330.—Shoe for the After Treatment of Club-foot.

Fig. 331.—Beely's Shoe.

vic strap on the opposite side of the pelvis. The cord must, of course, be tightened as the traction force relaxes.

Bonnet's apparatus (Fig. 333) consists of two splints for the upper and lower extremity, respectively, articulated at the knee and ankle. The internal splint terminates in a thigh strap; the external splint extends up to the trochanter and is provided with the ordinary joints for flexion and extension and is also jointed to a steel pelvic band at a right angle. The mechanism of the external splint maintains outward rotation of the leg (*vide* Fig. 29). Meusel's apparatus (Fig. 334)[46] consists of a pelvic strap with upper extremity splint articulating at the hip-joint and fastened at the condyles. The lower portion of the apparatus plays in the groove *a*.

This portion is made up of two splints for
ity, articulating at the knee and ankle and
The apparatus may be combined with any
and occasionally it is advisable to make
extremity splint somewhat shorter than t
to render the axis of the tibio-tarsal joi
Doyle[47] has accomplished the same obje
spiral rotatory springs represented in F
obtain outward rotation, has inserted an e

FIG. 332.—Bruns' Apparatus to Overcome Inward Rotation of the Leg.

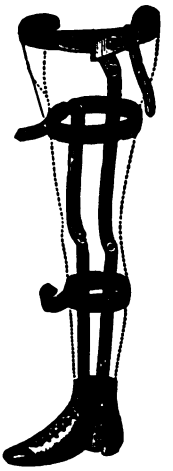


FIG. 333.—Bonnet's Apparatus.

FIG. 33
Over

the thigh splint. When this screw is turne
accomplished to the extent of three-quarte

For the purpose of preventing inversi
portion of the foot and inward rotation of
paratus has been devised with mechanism
feet and aiming at keeping the apices of t
nandale[49] has adapted to his club-foot ap
for everting the anterior portion of the sol
be desired.

Although, for the vast majority of cas
absolutely requisite, yet this operation will

the time necessary for treatment. In addition to the tendo Achillis, the tibialis posticus may call for tenotomy, particularly if it be very tense. While this tendon retains its normal course along the tibia in case of club-foot, below the internal malleolus it becomes stretched. Tenotomy of this tendon should be resorted to from above the internal malleolus (Stromeyer, Vogt) and the operation had better not be performed subcutaneously. A longitudinal incision, about one and one-half inches long, should be made down to the tendon above the internal malleolus; the tendon should be hooked up and cut with a blunt bistoury.

Section of the plantar fascia is also often a very essential step. This operation, originally recommended by Guérin, is to-day chiefly performed after the method devised by Parker[50] and Phelps, that is to say the section of the contracted soft parts on the inner border of the foot. Phelps'[51] method, as performed by Ph. Schede,[52] Nönchen, Cordua, Lauenstein and others, consists in the section of the tendo Achillis, of the plantar fascia, of the tendon of the tibialis posticus, and of the internal lateral or deltoid ligament. The incision is a circular one at the internal malleolus. Following the operation, the foot is straightened and suitably bandaged. Where all the tissues are tense (the third degree of Phelps), Phelps first performs subcutaneous tenotomy of the tendo-Achillis, and next, through an open incision extending between the lower and anterior border of the internal malleolus and Chopart's joint, he cuts all the tendons and the fascia, to the degree requisite for overcoming the deformity. The wound is bandaged antiseptically and, after the lapse of four weeks, a removable plaster shoe is applied, carrying a suitable ¬-shaped iron projection, and the muscles of the calf are subjected to massage and to electricity. In Fig. 335 is represented the case shown in Fig. 295 and treated after this method, and this is a striking instance of the good results attainable.

Fig. 335. — The Case of Club-Foot, Represented in Fig. 295, after Tenotomy and Orthopedic Treatment.

We may now pass to the operations on the bones suitable in case of club-foot, over a dozen of which have been proposed

and in regard to the value of which there is still room for skepticism.

Extirpation of the cuboid bone was proposed by Little in 1854 and first performed by Sully. According to Lorenz,[53] who resorted to this operation in eleven instances with generally bad results, it is only of value from an historical standpoint, seeing that it does not correct the plantar flexion and the internal border of the foot soon re-assumes a faulty position.

Extirpation of the talus has much more in its favor and has been warmly indorsed by Lund, Rupprecht, Reid, Vogt, Böckel, Bessel-Hagen, Margary[54] and many others on the grounds that the arch of the foot is retained, that there are no consecutive disturbances in growth and that there results greater mobility between the calcaneus and the bones of the lower extremity. Lorenz, however, deems the latter point objectionable on the score of likelihood of recurrence of the deformity, and he claims that the operation in the adult will frequently not correct the plantar flexion and that torsion of the foot often remains. According to Lund's tabulated results, the mean time required for union is six to seven weeks, and in this respect, therefore, the operation has nothing in its favor over others. Indeed, extirpation of the talus is advantageous only in so far as it has but little influence on the after-development of the foot.

As regards the technique of the operation, the procedures are various: Reid preferred a lateral, circular incision beginning behind the internal malleolus and extending over the heel to the antero-external side of the extensor tendons. The flap was rolled upward, the foot joint opened and the talus removed. Maas also made a circular incision above the talus. Lorenz found an anterior longitudinal incision sufficient. König[55] carried his incision from the external malleolus above the eminence of the lateral borders of the talus to the side of the extensor tendons below Chopart's joint. Rupprecht[56] resects a piece from the apex of the external malleolus in the belief that thus extirpation of the talus and subsequent redressement is rendered easier. Bessel-Hagen advocates chiselling off obliquely the outer side of the external malleolus. In children the cartilage of the lower end of the fibula must be avoided during any of these methods, lest the bones of the lower extremity develop unequally.

In a number of very aggravated cases it has been necessary, especially in adults, to remove pieces from the os calcis, the navicularis and the cuboid, and even to extirpate one or more of the cuneiform bones before it was possible to overcome the deformity. Hahn also removes a segment from the anterior process of the calcaneus. Albert has enucleated the talus and cuboid, Hahn the talus, cuboid and navicular, and West and Bennet the navicular and the cuboid.

Of the various resections, that of the head of the talus (Lücke, Albert) is performed by preference by Köcher[57] in cases which are not specially aggravated. Lorenz has reported two cases of paralytic pes varus successfully treated after this method and I can add a third case. In severe congenital club-foot the method does not seem appropriate, for it does not of itself remove the obstacle to correction, it being often essential to cut, in addition, the shrunken ligaments and the tendon of the tibialis posticus. Lorenz claims that the method is irrational, being followed by shortening of the inner border of the foot. Hüter's method of the removal of a wedge, with outer base, from the external portion of the neck of the talus has not found favor.

The procedure generally in vogue is wedge-shaped excision from the tarsus (O. Weber, Davies-Colley, Davy, Hirschberg). Lorenz[58] has collected ninety-one instances, the mean duration of treatment being six to seven weeks. This operation best fulfils the indications. It corrects the torsion and curvature and it compensates the plantar flexion. The function of the foot, owing to the subsequent stiffness, certainly cannot be compared with that of the normal foot; still, Mensell, Reid, Schede, and Roser[59] have recorded very favorable results as regards function, especially in connection with the talo-crural joint.

The methods of performing wedge-shaped tarsotomy are varied. O. Weber first removed a wedge from the cuboid and calcaneus. Davy and Davies-Colley removed the cuboid and then portions from the talus, calcaneus, navicular and cuneiform, exceptionally even the cartilage of the two last metatarsal bones. Nicoladoni removed only the caput tali and a piece from the proc. ant. calcanei.

The wedge of bone to be removed should have its apex, as a rule, in the navicular bone and its base in the anterior por-

tion of the neck of the calcaneus and in the cuboid. The tarso-metatarsal joint should be avoided. The base of the vertical wedge naturally lies backward, and the bones must then be resected to a greater extent. Many operators advise the determination of the requisite size of the wedge to be removed by experiment on a plaster cast.

After the removal of the wedge with a sharp chisel—the base of the wedge implicating the cuboid, calcaneus and talus, and the apex the navicularis—the tense ligaments of the sole of the foot must be cut and then, ordinarily, correction is possible. The wound must be dressed antiseptically and the position must be maintained by suitable orthopedic apparatus. Exceptionally the bone suture may be employed, and for this purpose Duret and others recommend *crin de Florence.*

The methods of incision for tarsotomy are also varied. Bryant makes a transverse incision over the dorsum of the foot, extending from the tuberosity of the navicularis to the outer border of the cuboid; a second incision is made along the outer border of the foot in order to cut the extensors. As a rule, however, owing to the displacement of the extensors (*vide* Fig. 279), this latter incision is not requisite. Bush's flap method is objectionable on the score that in case of paralytic club-foot the flaps readily become gangrenous. Albert makes an incision down to the bone along the outer, and a smaller incision along the inner border of the foot. The soft parts of the dorsal and plantar surfaces are next pushed off the bones, and then the wedge is sawed out. In the vast majority of cases, especially when the foot is not large, a longitudinal incision, parallel to the course of the extensor tendons, over the centre of the convexity, will suffice for the operation.

Although now, even under antiseptic precautions, the operations for club-foot are not without risk (Lorenz places the mortality at 1.25% and he estimates the risk to life at nearly 10 per cent), still, without question in chronic cases these operations are justifiable. In infants any operation on the bones must be considered erroneous, and although, owing to the social condition of the parents, extirpation of the talus, etc., is performed in many an infant, still such methods should here be rejected, being, as Lister and Guérin express it, unnecessary mutilation. For by means of suitable orthopedic treat-

ment, associated exceptionally with tenotomy or with Phelps' operation, the foot will continue to develop, even though the appearance of the foot is not essentially bettered (*vide* Fig. 336, *b*).

In the exceptional instances where in children an operation appears essential, enucleation of the talus is the most rational procedure (Lorenz, Rupprecht, and others) since it does not interfere as much with the development of the foot as, for instance, the wedge-shaped excision.

In adults, the conditions are very different and in cases of accidental pes varus resection is the only way of restoring function. In case of paralytic and congenital (chronic) pes

FIG. 336.—*a*, Bilateral Club-foot Before, and *b*, After Tarsectomy (Margary.)

varus at about the twentieth year, mechanical treatment has to overcome such obstacles that wedge-shaped excision here, as well, appears justifiable (Hirschberg,[60] Rydygier).

According to Lorenz, the interests of the patients demand that we should endeavor, by means of tenotomy and section of ligaments and of fascia, to limit the extent of the resection as much as possible. In regard to the choice between wedge-shaped excision and enucleation of the talus, opinion varies. Some favor the former, while the latter has warm advocates, and both methods have yielded good results. We reproduce two of Margary's[61] cases. In Fig. 337 *a* is shown a case of bilateral varus and in Fig. 337 *b* the result after extirpation of the talus, navicularis, and cuboid on the left side. In Fig.

338 *a* is seen a case of left club-foot and in Fig. 338 *b*, the same after wedge-shaped tarsectomy.

According to Bessel-Hagen, the statistics speak in favor of extirpation of the talus. In 122 wedge-shaped osteotomies there were 5 deaths, 45 distinctly bad results, in over 30 recurrence; in 61 talus enucleations, in 11 of which wedge-shaped

Fig. 337 a.—Bi-lateral Club-foot.

Fig. 337 b.—After Operation on Left.

excision was also performed, there was 1 death, and 57 good results.

In regard to paralytic club-foot, operations which aim at artificial ankylosis may be resorted to. These operations have been chiefly devised by Albert, and they are particularly adapted to poor patients who live in the country where treatment by orthopedic apparatus is not possible. Lesser and Rydygier[62] have lately described their methods. A longitudinal incision is made over the ankle joint along the fibula to the extent of two inches. A slender wedge, with base outward, is removed from the upper surface of the talus; the

cartilage is removed from the lateral articular surfaces of the talus and from the fibula and tibia; the deformity is corrected and the foot is dressed antiseptically in a fixation bandage. In order to insure the result, the patient should be made to wear a shoe fitted with immovable lateral splints.

Pes Valgus.—Pes valgus (flat, splay foot, *pes abductus pronatus reflexus* [Hencke]) constitutes that deformity where

Fig. 338 a.

Fig. 338 b.

the foot is pronated and abducted. The outer border of the foot is lifted upward, the inner looks downward, and the curvature of the sole is obliterated.

Pes valgus may be congenital or acquired. The latter is by far the most frequent and essential form, the reverse of what holds in case of pes varus, where the congenital form is usually met with.

Talipes valgus congenitus is ordinarily a calcaneo-valgus, and in the majority of instances the deformity is due to ab-

normal intra-uterine pressure (Tamplin, Lonsdale) or position (Lücke, Volkmann, Vogt). Exceptionally it is the result of defect in growth, such as a rudimentary development or defect of the fibula,[63] instances of which have been reported by Wag-

Fig. 339.—Acquired Pes Valgus.

Fig. 340.—Congenital Pes Valgus.

staffe[64] and Meusel. According to Küstner, 8.6 per cent of the cases are congenital. In 764 cases of congenital talipes, Adams found 42 cases of talipes valgus, 15 of talipes valgus on the one side and talipes varus on the other. Of the 42 instances, 15 were on the right side, 10 on the left, and 17 bilateral.

As characteristic points in congenital valgus, Küstner lays stress on the sharply pronated, abducted, and dorso-flexed position. The convexity of the sole is very marked. The dorsum is bent in, and, ordinarily, on the inner border of the foot, the caput tali and the navicularis project strikingly.

Fig. 341.—Congenital Talipes Valgus.

The anatomical alterations in congenital splay foot do not implicate the shape of the bones to any great extent, even in aggravated instances. As a rule, the heel is only slightly elevated, although, even as in pes varus, it may be sharply drawn upward (Fig. 341). This will vary, of course, according to the contracture of the muscles of the calf of the leg.

The talus is sharply directed forward and downward and is not essentially altered in shape. The navicularis suffers rotation around its antero-posterior axis, its internal portion sinking markedly downward. Its external portion, in slighter degrees of deformity, projects upward. In aggravated cases

there results convexity of the sole of the foot. The cuboid is rotated transversely. The relations of the bones of the tarsus at Chopart's and Lisfranc's articulation are somewhat altered. The ligaments between the talus and the navicularis are generally stretched on the inner side; the muscles are not

FIG. 342.—Pes Valgus Paralytic.

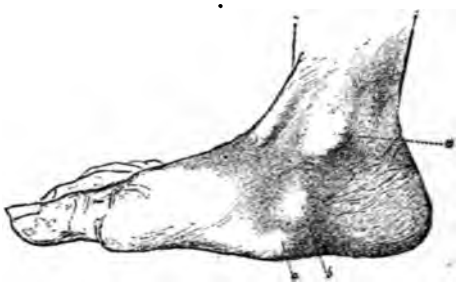


FIG. 343.—Pes Valgus in an Adult.

specially altered. In a number of instances Holl[65] found congenital coalition between the os calcis and scaphoid, and he thence concluded that when such a coalition is determined, it points to the congenital origin of the deformity.

Acquired splay foot is far more common than congenital. The differentiation is made between rachitic valgus (occurring

FIG. 344.—Spastic Pes Valgus in a Girl of 14.

FIG. 345.—Traumatic Pes Valgus Following a Railroad Accident.

in infancy and up to the fifth year) and typical or static valgus (developing at puberty). The paralytic variety (Fig. 342), the spastic variety (Fig. 344), and the variety due to trauma or to disease of the bone (Fig. 345) are very infrequent.

In 999 cases of acquired contracture of the foot, Adams found 181 instances of pes valgus, 80 of equino-valgus, 110 calcaneus and calcaneus-valgus. Rachitic pes valgus results from abnormal softness of the bones and it is usually associated with genu valgum or rachitic curvature of the thigh (*vide* Fig. 42).

Pes valgus adolescentium unquestionably is the result of abnormal lasting pressure, such as protracted standing. This is proved by the infrequent occurrence of the deformity in girls in the higher walks of life, and its frequency, on the other hand, in individuals with relaxed muscles and in those who are obliged to work hard in the standing posture, whence insufficiency of the muscles and relaxation of the ligaments result. It was formerly the belief that atony of the plantar aponeurosis (Stromeyer) and weakness of the muscles, particularly the tibialis posticus and those of the sole of the foot, were the first etiological factors in the production of splay foot; but the fact is, that protracted and increasing pronation of the foot, the result of pressure, constitutes the most essential factor.

There can be no doubt that the etiological cause of pes valgus adolescentium is abnormally frequent and long-continued pressure, and especially constant standing. It is therefore exceptionally rare among girls of the wealthier classes and is most often seen in persons of lax musculature whose growth has been rapid. Flat-foot is frequent in certain occupations for the same reason, letter-carriers, domestic servants, porters, etc., being often affected; their work being arduous and carried on standing, and their hours of recreation and sleep being too short, so that muscular insufficiency and ligamentous relaxation set in. Atony of the plantar aponeurosis has been regarded as the cause of the valgus by Stromeyer and others; weakness of the muscles, especially of the tibialis posticus and the plantar muscles, has been blamed for flat-foot; but there can be no doubt that the above-mentioned permanent position of the articulation, caused by pressure upon the foot, gradually leads to a sinking in and flattening of the arch of the foot; or, in other words, that the permanent and excessive pronation is the immediate cause of pes valgus.

Henke regards the condition a change of position of the component parts of the joint, from the widening of some and

the destruction of others of the articulations, and calls flat-foot *pes flexus pronatus reflexus;* in which view König and others agree with him. Hüter, on the other hand, regards it as a developmental deformity, an unequal distribution of the pressure upon the points of contact of the bones causing unequal growth of these structures. Lorenz has shown the untenability of Hüter's views.

V. Meyer inclines to Henke's opinion, but he regards the change of position of the articular parts not as a direct sinking, but rather as an overturning of the bones; claiming that the internal border of the foot and the lig. calcaneo-scaphoid would necessarily be lengthened if the former occurred.

Lücke[66] says: A complete flat-foot, and a complete abduction-foot (P. plano-valgus) can only occur when there have been changes within the joints, the articular surfaces having separated from one another, and having thereby caused a change in the shape of the bones.

Reismann[67] regards flat-foot as an actual contracture, first of the extensors, and then of the pronators, consequent upon insufficiency of the plantar flexors from over-exertion. But although muscular contracture is the most prominent symptom in some cases, we are not therefore entitled to base the entire theory of flat-foot upon a single phase of the condition.

Lorenz[68] has subjected the various theories of flat-foot to an exhaustive criticism, and I must refer the reader to his work for information. He has shown that an exaggerated position of pronation alone is not enough to cause articular changes similar to those found in flat-foot; for in addition to the motion between the astragalus on the one hand and the os calcis and the scaphoid bone upon the other, which is not rotation upon the axis of the joint, but is rather a motion from postero-externally to antero-internally, there is an actual sliding of the bones upon one another. Lorenz's exact pathologico-anatomical investigations lead him to this result: that "valgus acquisitus is caused by pressure, and consists of a sinking of the external portion of the arch of the foot, together with a partial sliding off of the internal from the external arch of the foot"

During the development of the deformity, there may occur irritative conditions of the periosteum in those places; they being either involved in the displacement (external surface of

the neck of the astragalus, parts of the upper surface of the neck of the os calcis) or they are implicated later in the formation of independent nearthroses (nearthor. calc. fib.; calc. nav.; talo-nav.; Fig. 347) (Lorenz).

The results of such irritation are the osteophytes and bony walls which are almost always found in such situation (Figs. 346, 347); these bony walls forming a kind of "self-limitation" to further development, and accounting for the fact that, under certain circumstances, flat-feet which are contractured

Fig. 346.—The Astragalus in Flat-foot. *x*, Bony Wall.

Fig. 347.—Reflexed External Arch of Foot. *a b*, Nearthrosis Calc. Fibul. (After Lorenz.)

Fig. 348.—Internal Aspect of Flat-foot. *a*, Tub. Nav., which forms a Fulcrum, and which is the deepest portion of the Internal Border of the Foot; *c*, Lig. calc.-nav.-plant., forming an arch between its two points of insertion *a* and *b*. On account of the adduction contraction of the middle portion of the foot, the metatarsus hal. appears shortened.

and with repeated active symptoms are of a more favorable prognosis than those which run a more torpid cause, and in which such a limiting bony wall is not formed in any such degree.

Changes in the bones and articulations, especially in the talo-tarsal articulation, occur in pes valgus acq. These cannot, however, be regarded as resulting from an actual osteitis, but rather as due essentially to the valgus condition of the calcaneus. For the calcaneus is now no longer situated under the middle of the lower limb; the astragalus, which usually rests upon the calcaneus like a lady on horseback (Starke)

has slidden off when the latter bone assumed a position of pronation, and pressed upon and stretched the lig. calc. nav.

The tibia and fibula show nothing abnormal in mild degrees of flat-foot. In the severer grades the point of the malleolus externus is somewhat flattened and rounded off; in the worst cases it is entirely flattened out (Fig. 347). The head of the astragalus is usually very prominent, the scaphoid bone being displaced upon it laterally, and being, at the same time, rotated upon its sagittal axis, so that its tuberosity is entirely beneath the border of the foot.

The astragalus is not essentially changed, the line of insertion of the capsule, even in high degrees of valgus, being on the whole analogous to that of the normal foot. But the relation of the cartilaginous border of the articular surfaces is altered, and the curvature of the astragalus is markedly flattened (Fig. 346).

The articular facets for the malleoli are changed in shape and direction, being displaced anteriorly without being covered with cartilage. While the cartilaginous coat upon the posterior surface of the astragalus is entirely normal, it is deficient wholly or in part upon the middle upper surface. Upon the anterior surface up to the insertion of the capsule it is absent (Fig. 348), the border between the anterior and middle parts being fairly straight and similar to the cartilaginous border in the normal bone. Hence the lengthening of the intra-capsular strip of bone is only apparent, and the internal and external surfaces are of equal breadth. The head of the astragalus is considerably changed in shape; it is divided by an obtuse angle into two surfaces, the greater part of its oval being taken up by the facets for the scaphoid bone. At the inner lower portion of the circumference of the head is the facet corresponding to the lig. tibio-calc.-nav.; and a small flat facet is frequently found in connection with it, for articulation with the median edge of the upper part of the neck of the calcis.

The more pronounced the flat-foot, the more does the apex of the navicular facet recede from the lower inner tuberosity of the oval head of the astragalus. It slips outward, upward, and backward, and the ligamental facet takes possession of the entire inner lower portion of the surface of the head of the astragalus (Lorenz).

In marked valgus the entire surface of the head of the

astragalus is taken up by the ligamenta
ception of a small part of its upper extern

In a number of cases the navicular fa
displaced beyond the normal external uppe
head on to the external border of the neck
tion is found on the anterior surface of the
alus in the form of a rounded tubercle wi
covered with coarse fibro-cartilage. In
hollow of the scaphoid bone extends over t
upper end of the oval head to the anterior
of the astragalus, and lies like a bridge ov
striction of the neck, forming a canalis

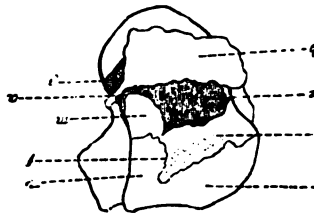


FIG. 349.—Talus of a Marked Case of Flat-foot, Viewed fro
Lorenz.) *c*, Upper curved surface covered with cartilage as in
surface covered with normal cartilage; *d*, upper curved surfac
covering; *m*, inner curved surface with defective cartilaginous
extent of the intracapsular ridge of bone; *b*, intra-articular
(shaded) remains of the intracapsular ridge of bone in the talo-

fact, the navicular bone has suffered an al
tion.

In other cases, the displacement betwe
tragalus causes, by means of periosteal ir
tion of an absolute bony wall (Fig. 350)
certain extent a lengthening of the extern
it is sometimes irregularly flag-shaped, but
ably regular in its outlines. Its anteric
rough and irregularly covered with cartil
the oval head of the astragalus can be di
three surfaces.

In the astragalo-scaphoid joint we find
in the intra-capsular ridge of bone. At al
widening at the inner border, as Hüter's th
it is rather lessened.[69]

In the calcaneus also, the changes incid

chiefly surface changes; the height of the neck of the bone being not specially affected. Along the external posterior surface of the articulation the astragalus is not in contact with the calcaneus at all, the surfaces being imperfectly covered with cartilage (Fig. 352).

In bad cases of flat-foot, this free border becomes worn down; and the fac. artic. lat. finally is composed of two surfaces meeting at an obtuse angle, the larger anterior and inner

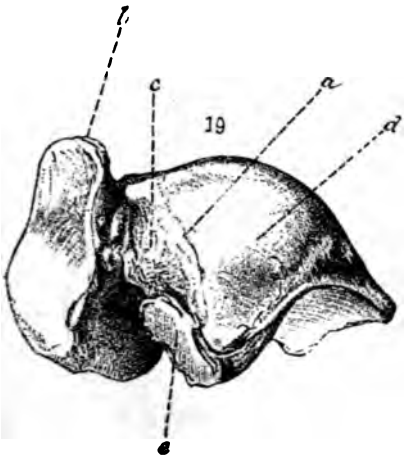


FIG. 350.—Flat-foot Talus from Without. (After Lorenz.) *b*, Ridge of bone on the external upper border of the oval head of the astragalus with nearthrotic surface; *a*, boundary line between the cartilage-covered posterior part of the lateral curved surface, *d*, and the anterior portion, imperfectly covered with cartilage. *c*: *e*, nearthrotic surface on the anterior margin of the lateral edge of the crest of the talus.

FIG. 351.—External Arch of a Normal Foot Seen from Outside. *ge*, Lig. Calc. Cuboid; *c o*, Profile of the Facies Artic. Lat., the surface of pressure in the external arch of the foot.

FIG. 352.—Sunken External Arch of a Flat-foot (after Lorenz), with the Formation of a Ridge of Bone, the Cuboid being displaced upward on the Fac. Cub. Calcan.; at *b*, the plantar edge of the Fac. Cuboid. rests upon the Lig. Calc. Cub., whose position is shown by *f g*.

one representing the remains of the joint-surface. The shortening of the calcaneus joint-surface caused in this way may be as much as two-fifths of an inch in aggravated valgus.

The joint surface of the sustentaculum tali begins to lose its cartilage at the anterior external and lower border in mild cases of flat-foot, in the worst cases of valgus acq. it may disappear entirely, and the sustentaculum tali may become a rough uncovered tubercle.

With comparative frequency there is found on the median upper border of the edge of the os calcis a cup-shaped facet, which, with the nearthrodic hollow on the anterior surface of

the body of the astragalus, forms a cor
the scaphoid bone.

Lorenz has also demonstrated the i
there occurs a movement of the lateral ed
on the neck of the os calcis—from behind
inward.

Like the head of the astragalus, the a
of the calcaneus may consist of two or of

The under portion of the lower joint s

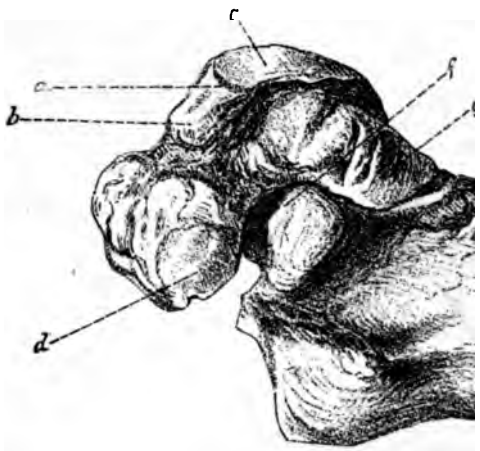


FIG. 353.—Astragalus and Calcaneus of a Flat-foot in their N
Within. (After Lorenz.) *a*, Boundary between intact, *c*, a
covering of the median side of the curved surface; the sustent
the sulcus tali instead of the facet, *d*, of the talus.

frequently an atrophic covering of cartilag
ered from the cuboid.

The os cuboideum shows special chang
grades of valgus, so that its anterior an
lose their normally parallel relationship,
becoming inclined forward and perhaps ir

The shape of the navicular bone is of
It becomes wedge-shaped, and its externa
may sink to about two-fifths of an inch.
cartilaginous covering may be lost, accor
with the astragalus is changed.

As regards the ligaments, flat-foot sho
ing (Lorenz). Thus it may be demonstrate
the ligaments between the astragalus ar

movements between the bones in various directions, but especially from behind externally to within anteriorly, just as in a loose amphi-arthrodial joint.

This shows that the ligamenta calc. interossea must have been stretched and become loosened enough to permit of motion between astragalus and calcis.

The lig. talo-calc. is lengthened and changed in direction; in very well developed valgus it may disappear entirely.

The lig. calc. fibulare in aggravated cases forms an acute angle with the fibula; and in case of a nearthrosis between the point of the fibula and the calcis, it may be entirely destroyed.

The lig. tibio-calc.-nav. and the lig. calc.-cuboideum are always stretched and lengthened; while the lig. calc. nav. interosseum, when not destroyed, is always shortened.

As regards the positions of the joints in flat-foot, in bad cases the talo-tarsal joint is not only in a position of pronation, but the astragalus appears to have slipped off the calcis entirely. With respect to the articulatio calc.-cuboidea reflexion of the joint occurs when the external arch of the foot is flattened.

Fig. 354. — Outlines of an Adducted Flat-foot seen from Above. (After Lorenz.) Note the zigzag course of the Axes of the bones.

The talo-crural joint is in a state of greater or less plantar flexion in flat-foot. This may be considered a compensatory movement, for it is a direct consequence of the sinking of the external arch of the foot. In aggravated cases, the motion of the joint is almost entirely lost, only a slight amount of dorsal flexion being obtainable. The normal arc of motion of 76° to 80° sinks to 45° or even 32° (Lorenz).

Finally, in well-marked cases of flat-foot we must not forget the contracture in adduction of the metatarsi, which gives the inner border of the foot a peculiar zigzag course, as shown in Fig. 354. The head of the astragalus forms the most internal point, and the notching of Lisfranc's articular line can be plainly seen.

If we draw a straight line (*d h*) from the median curved surface, the distance from it to the tarso-metatarsal articulation, in high degrees of flat-foot, is, according to Lorenz, about one and one-half inches instead of about one inch in the nor-

mal pronated foot. The distance, *k h*, of from the line will be about one inch, as a quarter inches ordinarily.

The angle, *m n s*, formed by tarsus and 170° normally; it is here diminished to ab

As to the symptoms of acquired flat-fo plies, they consist mainly of a flattening foot, and a depression of the proc. ant. c of the astragalus (Fig. 355). In rachitic of rickets in other places will rarely b curvature of the limbs being present wit A fixed contractured position does not, result from the rachitic valgus of childho

In pes valgus adolescentium, evidences

FIG. 355.—Pes Valgus Ad. *a*, Tub. Navicularis; *b*, caput tali; *c*, malleolus int.

ra W sta the er an the an of the ner

the tendo Achillis seems tenser than na the foot is abducted, the toes are exten rior foot is pronated. Under the prominen *c*, is seen a rounded prominence (flat-fo It consists of, first, *b*, the caput tali, bel this is *a*, the tub. *o*, navicularis. The foo prone to be covered with sweat. Not in cles are imperfectly developed, and the ve

The consequences of pes valgus are a h ging gait; the patient is easily fatigued much exertion. Hence flat-footed persons army.

In accordance with the grade of functi distinguish a torpid and an inflammatory severe case of valgus the functions of the interfered with, the mobility of the astrag

to dorsal flexion, and that of the talo-tarsal joint in respect to supination, being diminished. Not infrequently the faulty position becomes a fixed one, and the pes valgus becomes a contractured valgus.

In these latter cases, the symptoms become very typical, and the subjective troubles of the patient reach a high grade. Characteristic and violent pains (tarsalgia) appear, located in those joints that are most affected.

The French authors call this condition *tarsalgie des adolescents* (Guérin, Gosselin) or *pied plat v. douloureux* (Terillon), while with us the designation of *inflammatory* or *acute flat-foot* (Volkmann) prevails. Neither term is very appropriate. There is no real inflammation of the joint, but rather localized traumatic irritation of the periosteum, causing the appearance of the ridges of bone above mentioned. The term *contractured static flat-foot* (König, Lorenz) is perhaps the most appropriate one.

The condition usually appears after excessive exertion, a long march, or prolonged dancing. Violent pains, with pronation, abduction, flattening, and especially fixation of the foot in the above-mentioned position mark its advent. In very pronounced cases the tension of the tendons (tib. antic., peronei, Achillis) can be plainly seen; and the muscular contracture becomes more marked when we attempt to overcome it by passive motions. The mobility of the ankle joint is diminished; pronation and supination cannot be effected, since motion between the talus and calcaneus is suspended. There are almost constantly present certain characteristic painful points (Hüter), corresponding to the tuberos. oss. nav., the head of the astragalus, and the processus ant. calc.; for the lig. calcaneo-nav. is tense and stretched and the entire foot is compressed by the extreme pronation. Other painful points in the sole and over the metatarso-phalangeal joints (Lücke [70]) and at the lower tibio-fibular junction sometimes appear. Local œdema occasionally occurs, which has led some observers to predicate the existence of actual inflammatory action (Gosselin, Lanneloque). The contracture that occurs is probably an instinctive fixation by muscular action similar to that which appears in joint inflammations (Roser).

The diagnosis in the early painful or intermittent stages sometimes presents difficulties. Not infrequently a commenc-

ing osteitis, a neuralgia, or rheumatis
(Lücke). When young persons complain
when they walk and stand, they should
tioned as to occupation and habits. The
ined and compared with its fellow. If
of the foot should be taken upon pape
besides the normal track (Fig. 357) consi
edge of the sole, the ball of the foot and
less part of the internal border will be
in accordance with the amount of the arc

As regards the course of pes valgus, t
three stages: one of development, a pai

FIG. 356 a. and 356 b.—Print of Sole in Severe Pes Valgus.

F

tractured stage. But the affection may
any stage of its development if the con
it alter. There is usually permanen
marked disability (inelastic gait, etc.). I
duction pain will seldom be wanting. I
contracture is usually present, and the
incapable of any protracted exertion.

In the less severe cases the contract
if the foot is not used for a day, and cold

Even if untreated not all contractu
stiff; and especially in individuals over
there occurs an accommodation of the m
joint relations. Only in a small propor

nutritive shortening of the muscles; but in these cases a luxation of the peroneal tendons over the malleolus ext. may even occur. The consecutive irritation may interfere greatly with motion, and may even cause complete ankylosis of the tarsus.

Flat-footedness is therefore an affection that deserves attention even in its first stages. By appropriate measures its progress may be checked. The prognosis is best for valgus dependent upon muscular weakness, and is not bad for the rachitic form in its early stages. It is fairly unfavorable, however, as regards restoration of function in marked cases of inflammatory valgus.

Prophylaxis also is possible. Good general nutrition, baths, massage, and the avoidance of over-exertion of the feet, and

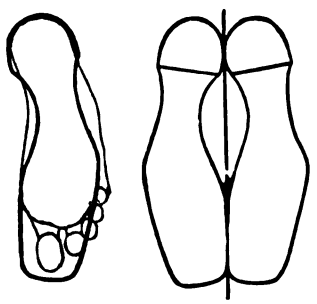


Fig. 358 and 359.—Correct Contour for Shoes. (After Meyer.)

Fig. 360.—Spring Sole Apparatus for Flat-foot.

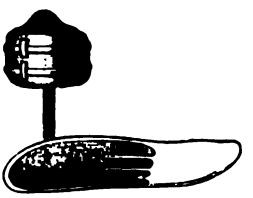


Fig. 361.—The Same with Lateral Piece. (After Beely.)

especially of standing much in beginning cases of tarsalgia—these measures will tend to prevent the development of the affection.

Gymnastic exercises, active and passive motions of the feet, and attempts to walk upon the external surface of the naked feet, have been recommended especially by B. Roth.[71]

The use of electricity, both induced and constant current, is to be recommended. The mechanical treatment of pes valg. cong. consists of mechanical replacement in as correct a position as possible, and fixation there by firm bandages, or Volkmann[72] recommends gutta-percha splints for that purpose, attached to the extremity with bandage or plaster.

Tenotomy is rarely necessary in flat-foot, though Tamplin[73] and others have recommended cutting the ext. communis, the peronei, the tib. antic., and even the tendo achillis.

The rachitic flat-foot must be prev
worse by some supporting apparatus. A
is a Scarpa's shoe with tension in the op
with an articulated piece to be applied to
leg, may be employed. Suitable anti-racl
not be neglected.

In congenital pes valgus, also, when p
ble apparatus is indicated. The importa
apparatus correct and redress the deform
sible, keeping the foot somewhat supinate
the tendency to further flattening of the a

The shoes should be laced, and shou
ankle. The inner edge of the sole should
external margin. The heel should be of m
one and one-half inches), broad, and pla
that it reaches the region between the
cuboid, so as to keep the neck of the ast
The sole should be gradually bevelled off
have a suitable adduction-curve (Myer, I
give a pattern of a proper sole to the sho

Soft elastic compresses placed under
were formerly employed. Lorenz has
complete uselessness. A properly shape
ever, suitably padded, such as Reynders
may be used instead of the crooked thick
port almost the entire breadth of the foot
into separate springs lengthways and tra
Wolfram, etc.) Such a sole may be mad
model of the foot, and it may be suppli
lateral splint which is fixed by a band al
361). It should not be immovably fixed to
there was always an internal piece artic
attached to the flat-foot shoe. Some r
splints fixed to a garter below the knee, o
tached in the same way to sustain the arc

Lorenz recommends an external splint,
surface of the foot with a leather band.
has a thick external wall and a cap for th
gradually to the external border and ba
which is broad, placed well forward, ar
inches high.

But patients with flat-foot frequently apply to us only when they suffer pain—when contracture has set in; and even if rest soon eases the pain the patient's ability to work is nevertheless much diminished. No one can reconstruct an arched out of a sunken foot; developed flat-foot is not an object for our therapeutic efforts (Lorenz).

If any operation is to be recomended it is that of forcible reduction under anesthesia into a somewhat supinated position (Roser), with subsequent retention for a month or six weeks by a plaster bandage. The plaster may be replaced in a few days by a starch bandage (König), or it may be covered with leather so that it may be used in the street.

It is conceivable that under the altered pressure-conditions, the anatomical changes may retrogress to a certain degree. But atrophy of the muscles is liable to occur under the permanent bandage.

Tenotomy of the peronei (Barwell) can only be necessary in the rarest cases.

Hausmann mobilizes flat-foot by means of the apparatus which has already been shown in Fig. 249, which pulls the internal border of the foot upward, and the external border downward. In the short time of two or three weeks the most aggravated fixed flat-foot may be brought into extreme supination, and this, if the foot is massaged once daily, without injuring the skin. A removable plaster boot for flat-foot is then employed to maintain the position. A patient can wear such a boot at least three months, even in bad weather. After placing a pledget of cotton in front of the toes, an ordinary woollen sock is put on. A closely folded piece of flannel is then sewed under the site of the arch. A stout piece of paper-maché forms the sole. With the aid of three long plaster bandages a shoe is made which may be strengthened on each side with pieces of sole leather. While the bandage is setting the foot is to be kept pressed into normal position. The dorsum is then cut up, the whole is covered with leather and provided with a sole and a broad low heel.

It is for the paralytic pes valgus that an artificial substitute for the lost muscular tone may be provided by means of elastic traction (Duchenne). The tibialis ant. and post. especially may be thus supplemented. The simplest way is to support the arch of the foot by an elastic bandage running inside

the shoe and attached above to the circular piece connecting the two lateral splints (Fig. 362).

None of the older valgus appliances are much used to-day. I figure here Adams', with an internal lateral spring, an endless screw corresponding to the joint, and a valgus pad on the inner surface of the sole.

It is only in the severest cases of irreducible contracted valgus that bone operations are to be thought of. Our experience concerning them is yet insufficient. Bennet proposed to excise a wedge-shaped piece from the side of the astragalus, without opening the joint.

Ogston[75] attempted to produce a synostosis between the

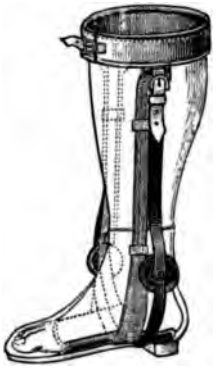


FIG. 362.—Reynders' Apparatus for Paralytic Pes Valgus.

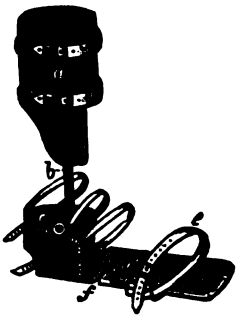


FIG. 363.—Valgus Apparatus. (After Adams.) For Cases of Medium Grade

astragalus and scaphoid bone in the redressed position. By a longitudinal incision on the inner side he exposed the joint and the caput tali without injuring periosteum or ligaments. He then chiselled so much off the articular surface of the head of the talus and the scaphoid bone that redressing could be effected. Then boring two holes obliquely through the navicular bone into the talus, he inserted two iron pegs to nail them together. He then applied an antiseptic dressing and a plaster bandage. After three months he allows the patient to use his feet. Up to 1884 he had done the operation seventeen times, in ten patients. Kendal, Franks, Livàn, etc., recommend it.

Stokes[76] regards the essential change in flat-foot as skeletal, and believes that that of the ligaments is only secondary. He therefore recommends osteotomy of the astragalus. Based

upon one successful case, he directs an incision to be made along the inner border of the foot over the head of the astragalus one and one-half inches long. Another incision meets this at right angles somewhat behind the line of Chopart's amputation incision. After turning back the flap, a wedge-shaped piece of bone, with its base downward, is removed by means of the osteotome from the enlarged neck and head of the astragalus. By adduction and supination the arch of the foot can be re-established. An antiseptic dressing is put on, and Dupuytren's fibular splints maintain the whole in place.

Even extirpation of the talus has been recommended for pes valgus (Vogt).[77]

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CHAPTER VII.

DEFORMITIES OF THE TOES.

DEFORMITIES of the toes are frequently regarded by physicians as hardly worthy of notice; and, though they often give the patient much trouble, he rarely obtains relief. Only a small proportion of deformities of the toes are congenital; most of them are acquired from improper shoeing of the feet; for this latter is the chief factor in the etiology of affections of the toes.

The accompanying figure will show the extent to which the deformity may extend. It is from the Munich Pathological Institute. The small toe is curled over the others, the great toe is reflected dorsally, and the nails have degenerated into long claws.

FIG. 364.—Deformities of the Toes from Improper Shoes.

The toes may be displaced transversely or vertically. The former is peculiarly apt to affect the great toe, and is therefore of especial importance.

Most important of all probably is the external deviation, the abducted contracture, of the great toe, hallux valgus. Instead of being a continuation of the first metatarsal bone, the great toe lies across the other toes, either above or below them. Hence the metatarsus and the great toe form a more or less acute angle with one another, and the head of the first metatarsal bone is more or less abnormally prominent. Not infrequently the bursa over the head inflames, and it may lead to the establishment of a fistulous opening. This extremely painful and disabling condition is a "bunion," in French "oignon." If the inflammation does not go so far as this, callosities and corns may appear.

Hallux valgus is more frequently, though not exclusively, seen in elderly persons. It sometimes seems as if the process

had some connection with chronic rheumat
tions. Very marked cases are rare in y
although I have recently seen one in a b
Position in life does not seem to affect its
rence. Malgaigne supposed there was we
nal lateral ligament, and he and Dubreuil
retraction as the cause of the affection.
there was a retraction of the extensor hall
in most cases the cause is to be found in
proper shoes, in which the internal bord
straight line, and the great toe is theref
the others (Fig. 365). It occurs the more

Fig 365.—Position of the great Toe in Consequence of Faulty Pointed Shoes.

Figs. 366 and 367.—I
Sole. (After v

heels are worn, since then the phalango
abnormally pressed upon.

The sharp toe of the modern shoe is no
if only the inner edge of the shoe is straig
responds to the great toe (Fig. 367). The
only partly filled by the toes, which of cou
for their development.

The anatomical changes in hallux valg
studied, vary a good deal. Not only is th
but there appears a bursa, often multilocu
nent head of the metatarsal bone. The ba
often displaced entirely from the head of t
and a new articular surface is formed for
latter bone. The head of the metatarsal
only with the elongated capsule and th
lateral ligament; the cartilaginous coveri

perfect (Fig. 369). The furrow in which the two sesamoid bones glide is frequently crooked instead of straight. Not uncommonly ossified cartilaginous outgrowths or peculiar

FIG. 368.—Position of Hall. Valg. in Comparison with the Bones of the Normal foot.

FIG. 369.—Hallux Valg. (Transverse Section). *x*, Exostosis.

ridges of bone appear behind the articular surfaces, which (like the similar ones we saw occurring in pes valgus) are to be regarded as the products of periosteal irritation. Sometimes, again, there is an actual exostosis from the head of the metatarsal bone that is thus relieved from pressure—as is well seen in a section of such a preparation (Fig. 369)—only that portion of the head articulating with the base of the phalanx

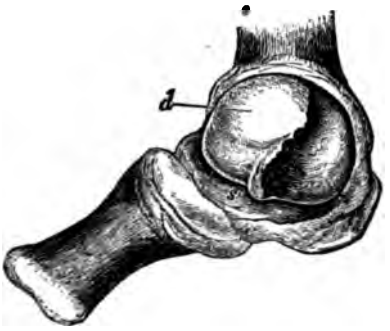

FIG. 370.—Hallux Valgus. Only the Surface, *d*, is in Contact with the Phalanx and Covered with Cartilage.

FIG. 371.—Hall. Valg. in an Elderly Woman.

showing a cartilaginous covering (*d*, Fig. 370). In articular surfaces which are no longer in apposition we find smooth surfaces, fibrillation of the cartilage, etc.; in short, a fairly marked

picture of arthritis deformans. Even the little bones may participate in this process; in several specimens I found their cartilaginous covering wholly or partly gone. The flexor and extensor tendons glide off externally, the soft parts on the external side are shortened, while the inner ones are more or less stretched.

The symptoms of hallux valgus consist chiefly in the abnormal position of the great toe. It is usually situated beneath its neighbors, not above them. We also note the abnormal prominence of the head of the first metatarsal bone. The callosities and bursæ forming upon it may inflame and suppurate. Even caries of the joint may occur. Very much pain and suffering may be caused in this way. Pitha tells of a seventy-five years old surgeon who, driven to desperation, cut off both great toes with a chisel.

The treatment in the first place consists in proper shoes, so avoiding an aggravation of the condition. The boot should be large enough, and its inner edge should be straight. If a painful nodule has already formed over the joint, a slight prominence may be made for it, and a large bunion-plaster can be worn to protect it. In slighter cases orthopedic treatment can consist of a roll of adhesive plaster of appropriate width being wound around the great toe and then passed along the inner border of the foot to the heel, and then back again to the base of the metatarsal bone. Strips of plaster or a roller bandage may be employed for fixation. An elastic bandage may be applied in the same way.

According to Lothrop[1] the finger of a glove may be passed over the great toe, and adduction effected by an elastic band or by plaster.

König recommends forced reduction followed by a plaster bandage; a method, however, which is useless when once the affection has become marked.

Pitha[2] recommended the wearing during the night of a kind of sandal with a spring attached to its internal border, toward which the toe was to be drawn. Similar to this is the apparatus of H. Bigg,[3] which can be worn within the shoe, and consists of a lateral spring with an oval ring for the articular region (Fig. 372).

The tenotomies and divisions of the lateral ligament formerly recommended are not very promising; and the same

may be said of the subperiosteal resection of the head of the metatarsal bone, which Hüter proposed, and Hamilton, Rose, and others recommended. Sayre performed the operation successfully; but it only seems to be indicated in cases of suppuration of the joint.

In all other cases, where there is much disability, or bursal inflammation, a wedge-shaped osteotomy of the metatarsus, such as Barker[4] describes, or the removal of the internal exostosis, as done by Reverdin and by Riedel, is our best resource. With appropriate antisepsis the chisel is the best instrument for the purpose.

Riedel's experience warns us to be careful in these resections; since, after an apparently entirely successful operation of the kind, he was compelled to remove the heads of the other metatarsal bones also, on account of the violent plantar pains caused by the extra pressure on the tarsal bones which made them bore into the sole.

Riedel's experience has taught him that resection is permissible only when flat-foot is present.

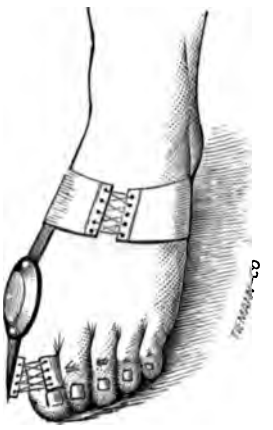

Fig. 372.—H. Bigg's Hallux Valg. Apparatus.

Of much rarer occurrence than hallux valgus is the contrary deformity of the great toe, in which it is drawn toward the middle line of the body—the pigeon toe, or adduction contracture.

The affection may occur alone, or with equino-varus or genu valgum. It may cause much spasmodic pain. A sandal with an appropriate contrivance for retaining the toe in the correct position, massage, and manipulation, will as a rule be sufficient to cure the condition. A tenotomy of the abductor hallucis will rarely be necessary.

Lateral deviations of the middle toes, crossed or riding toes, are rarer. They frequently lead to ingrowing toe nail. A suitable footgear is the most important point in their treatment.

Of vertical displacements we have those caused by flexion of the toes, those caused by extension of the toes, and those in which the first phalanx is extended and the others are flexed.

The latter affection is the commonest. Flexion and contrac-

ture of the toe, hammer toe, *orteil en ma*
is most frequently seen affecting the s
374).

According to Starke, too short shoe
etiological factor of the condition. As a
tial paralysis passed through in childhoo
the great toe. The metatarsi are mos
flexed, and the toes are dorso-flexed
phalanx.

Here also cramp-like pains occur, esp
Callosities are very liable to develop

Fig. 373.—Hammer Toes.

Fig. 374.—Appar

heads that project in the sole of the fo
puration, and fistula may occur.

Sandals provided with elastic loops f
used (Fig. 374). Mollière recommends el
the caput metatarsi upward. If there is
otomy of the extensor tendons or of the
dicated. Appropriate after-treatment, h
neglected. The foot must be fixed to a
shoe with low heel and an inclined plane f
Tenotomy of the flexors, practised by G
dicated; the division of prominent fascia
sary (N. Smith).

With the smaller toes, if there is mu
siderable anatomical change, exarticulati
of quickly and radically curing the troub

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CHAPTER VIII.

PARALYTIC DEFORMITIES.

THE paralytic deformities form a series of characteristic orthopedic affections, and may be caused by various central and peripheral diseases.

Infantile paralysis, idiopathic poliomyelitis anterior, has been well described by Heine. Rilliet and Barthez rather improperly designate it *paralysie essentielle.* It usually occurs in perfectly healthy children of from one to four years of age; but analogous cases have been seen, though rarely, in adults (M. Meyer). After a short initial stage, fever, exhaustion, convulsions, and even sopor occur, followed suddenly by more or less extensive paralysis, usually affecting the lower extremities.

The pathologico-anatomical changes have been especially studied by Charcot, Joffroy, Roger, Money,[1] Kussmaul. The brain is almost always normal; the spinal cord, however, shows acute inflammation of the anterior grey columns (hence called poliomyelitis ant. ac. by Kussmaul). Localized especially at the lumbar and cervical enlargements, the inflammation causes destruction of the ganglion cells and a consecutive atrophy of the anterior roots.

Muscular atrophy is usually readily recognizable, wherefore Duchenne called the affection *paralysie atrophique graisseuse de l'enfance.* But simple atrophy without any fatty degeneration may occur (Laborde).

As regards the frequency of the affection, the statement of Holmes Coote shows that out of 1000 sick children in the Royal Orthopedic hospital, 80, or 8%, suffered from infantile paralysis.

The sudden advent of the muscular disability is characteristic; for without any previous symptoms it may occur in a really apoplectic manner.

Characteristic also is the fact that t
ately reaches its maximum in extent and
to retrogress in a few days or weeks; so
at all events, is very rapid. In a gene
that the paralysis which does not disa
will be permanent.

In more than two-thirds of the cases
are affected, and especially the feet (81%,
oplegias are most frequent, and next par
and crossed paralyses being rare. In
paralysis is partial, some muscle-group
others being normal.

Thus even when there is marked par
ties the
usually
and th
being n
upper
muscle
arm th
ments
hands
mal.

FIG. 375.—Paralysis Infantilis. (After Rockwitz.)

Atr
muscle
monstr
two to
müller); the affected part is cool, relax

Disturbances of sensibility and affecti
are absent; mild contractions of the mu
time to time long after the paralysis has

Mental or sensory disturbances do no

The reaction of these paralyses to t
important. The nerves no longer reply
vanic current. The muscles act similarl
rent, but are affected by even a weak ga
occurring a stronger anodal closure cont
cathodal closure contraction). Even aft
current causes a long-drawn contraction
cles.

The reflexes are usually much dimini

tellar tendon being absent. After a time (Seeligmüller[2] has observed pes equinus four weeks after the appearance of the lesion) the altered pressure relations, weight, etc., cause contractures and deformities, especially of the lower extremities. Thus we see contractures of the knee and hip, talipes, and paralytic spinal curvatures. In accordance with the amount of sliding on the floor and bending of the limbs, we have peculiar and often very ugly deformities of the limbs (Heine).

The affected limbs undergo further and further trophic changes; they atrophy, and remain livid and cool. Their growth, also, is interfered with; and hence arise pelvic deformities, static scolioses (Fig. 126), especially when the paralysis is unilateral.

In rare cases all the muscles of a limb may be paralyzed; the patient then has a perfectly lax "swinging leg."

By far the most frequent are the paralytic contractures of the feet, causing equinus most frequently (equino-varus), and more rarely calcaneus, calcaneo-valgus, or pure valgus.

If the foot, from the superincumbent weight and the sinking of the fore-foot, becomes fixed in a position of plantar flexion, one of the most frequent of these deformities, the pointed foot, occurs (Figs. 254, 255), which mostly appears as an equino-varus. This is especially the case in young children that do not walk, there being no counter pressure upon the supinated foot; and also in those who move on crutches after the setting in of the paralysis.

Pes calcaneus and calcaneo-valgus (contracture in dorsal flexion and pronation) are rarer; for the dorsal flexors retaining their power and the plantar flexors being paralyzed, gravity opposes the formation of such a contracture. Only in cases when the foot is permanently used for walking, and is forced into dorsal flexion with abduction and pronation, the muscles opposing the pressure being paralysed, does the disability increase until the meeting bones and tense ligaments stop it. This barrier also, however, ultimately gives way.

In the knee-joint, also, we sometimes find contractures, usually in flexion on account of the preponderating frequency of paralysis of the quadriceps femoris. This is especially the case with children that only creep on the floor or who use crutches; since the knee and hip-joint are then kept flexed to keep the point of the foot from the ground.

As a usual thing the patient's night's r
act the tendency to contracture, and in h
sis the condition at the knee is rather th
joint is abnormally loose and shaky, fo
gelenk."

The children walk by employing the
sors of the thigh to bring the knee forwa
ing motion, and then letting the body w
knee that it remains hyperextended. T
then falls behind the base of the foot;
femoral and tibial joint surfaces upon one
limb bending anteriorly, and the tense c
hold it in place behind. These latter
eventually give way, and we then have
knee (Fig. 227).

In the hip-joint contractures from in
rare. If they do occur it is in neglected
months curled up in bed, or only creep a
or who have used crutches for a long tin
tractures of the hip lead to a compen
375), since the pelvis must incline itself
contracture, and the spinal column mu
centre of gravity correct.

The function of the glutæi in walking
fix the pelvis that the long muscles of
point of insertion. When the glutæi ar
rior part of the pelvis sinks downward fr
the psoas and iliacus.

A condition corresponding to genu re
in the hip. There the tension of the lig.
vis posteriorly, and a lordotic curvature a
column naturally occurs. If the lordosi
the ligaments of the hip are relaxed, the
pearance of the condition to congenital
(Fig. 386) may be very marked. In fact,
location of the hip in infantile paralysis
(Reclus).[3] The contraction of the intact
is paralysis of the glutæi and pelvi-t
favors the occurrence of such luxations.

In very extensive paralysis the extre
lax, as in a doll; hence the designation, *ja*

Paralyses of the dorsal and abdominal muscles always cause anterior curvature of the spinal column. Besides the lordosis there occurs compensatory kyphosis in the upper portions of the column and even skoliotic curvature, in consequence of infantile paralysis. This latter may be entirely static in its nature and be due to shortening of a limb; or it may be due to unilateral paralysis of the muscles of the back and consequent unequal pressure.

Deformities of the upper extremities in consequence of infantile paralysis are much more rare; and the mechanical conditions leading to contractures and deformities are almost entirely absent.

The shoulder joint rarely becomes fixed by the simultaneous contraction of the pectorales and the lat. dorsi. More frequently we find a paralytic subluxation present, in which the weight of the arm has caused the capsule and ligaments to elongate, and the humerus has sunk so far that there is a distinct hollow between it and the acromion. The total atrophy of the deltoid renders the condition still more marked (see Fig. 376). The fingers are flexed into the palms; the hand is slightly flexed. If the hand be more strongly flexed, the fingers may be passively extended. If the fingers be flexed, the hand may be extended to at least 180° (Volkmann). This variety of contracture depends upon the amount of use made of the hand, and also upon whether the flexors or the extensors or both are paralyzed.

Fig. 376.—Right-sided Paralysis of the Shoulder Joint.

Another typical affection, which causes paralyses as frequently as infantile paralysis, but much less commonly leads to contractures, causing mostly pes equin. spast., is the cerebral paralysis of children (hemiplegia cerebr. spast.) (Heine, polioencephalitis acuta). Strümpell has especially studied it, and has located the disease in the cortex.

Pathological anatomy has also shown the presence of atrophic processes, parencephalitic defects in the motor territory of the cortex (cicatricial remains of inflammatory action), frequent embolisms, thromboses, and hemorrhages; but all without any special localization in the gray matter of the cortex (Wallenberg[4]).

The children are apparently healthy and, after a short

initial stage of fever, vomiting and convı
attacked with the paralysis.

Hemiplegias are commonest, mono
Though the arm is usually affected mo
paralysis is generally not so complete as
Most of these children learn to walk ag
may be a halting one.

Ataxia, and a permanent clumsiness
may be left behind. The intelligence ma
in right-sided paralyses there may be spe

Attempts at passive motion soon sh
to deal, as in infantile paralysis, with a r
tion; tension of the muscles is plainly pre
condition rarely leads to absolute contrac

The muscles and nerves preserve thei
and—an important point for differential
no trace of a degeneration reaction.

The tendon reflexes are not only pre
frequently exaggerated on the healthy and
on the affected side.

But the cerebral paralysis of children
guished from the spinal by the motor irr
the paralyzed limbs. Finger, hand, and
quently spasmodically retracted, peculiar
ally turned. The paralyzed limb shows
tendency; and the hands and fingers espec
iar spasmodic motions, which are genera
peripheral muscle-group. They often con
slow motions of extension and flexion, a
athetosis by Hammond. The involuntar
especially liable to occur on intended mot
toes are stretched out like claws, and sep
on one side only—hemi-athetosis. Occ
tor-irritation symptoms are so consider
epileptic.

The sensibility of the affected part i
disturbed, nor is the temperature or color
or fright at passing water, or involunta
occur. Bladder and rectum are never aff
tile paralysis.

Paralytic contractures rarely occur.

other deformity than pes equin. spast. and contracture of the knee, with occasional adduction of the thigh in addition.

According to Heine, curvatures of the spinal cord do not occur in cerebral inflammatory paralysis.

The treatment of these paralyses falls within the domain of internal medicine, and consists of central galvanization, strychnine injections (beginning with one-sixty-fifth of a grain,) baths, hydrotherapeutic cures, etc. Gymnastics, massage, and the peripheral application of the electric current must be lauded; patiently applied we will see the vitality of the affected limb gradually increase. Above all it is necessary to prevent the appearance of contractures and deformities. Thus where the foot tends to sink it should be retained by a bandage in a rectangular position. Ready shaped gutta-percha splints are useful; the foot can be retained in one by a flannel roller bandage or by plaster and elastic bands. Frequently it will be sufficient to heighten the shoe at the side to which the foot sinks, and generally to see that the patient wears laced shoes, which hold the foot in proper position. These children should not be left to themselves. They should be provided with mechanical arrangements and put on their feet (Fig. 378).

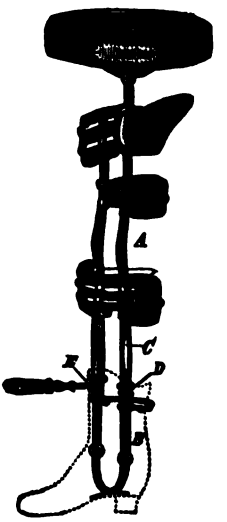

Fig. 377.—Nyrop's Sustaining Apparatus for Paralysis.

The use of crutches must be entirely forbidden; they predispose to the development of deformities. If contractures are already present, gradually increasing manipulation, plaster bandages (sometimes after tenotomy), must be employed to correct them. Various splints and supporting apparatus can then be employed; so that these unfortunate cripples need not drag themselves around like quadrupeds. Such apparatuses are necessarily of varying height, in accordance with the extent of the paralysis. They should be made light and graceful, and fitting well to the limb, without any constrictions, which would further the atrophy. Such machines (Fig. 377) usually consist of side splints with hinges at the joints which can be fixed immovably; they are covered with leather, sili-

cate of soda, etc.[5] Where only a few m
artificial muscles, to a certain extent rep
organs, may be employed. Duchenne a
structed such with elastic bands of rubbe
about them under the head of paralyse
again, elastic springs, or lateral spiral sp

Fig. 378.—Walking Apparatus, for Spinal Paralysis; Papier Maché Apparatus with Movable Hip and Foot, and Fixed Knee Joint.

alyses of the entire lower extremity and t
must reach up to the hips; there must be
tuberosity of the ischium, and steel ba
back or a suitable corset arrangement m

A practical apparatus for the purpose
Heusner,[6] in which the girdle is replaced
legs of strong but soft material, to be
They are very secure. The pelvic girdle a
the lateral pieces is a broad piece of cloth,

with buttons in such a way that the child can loosen it when it wants to go to stool (Fig. 379).

Rockwitz[7] describes an apparatus which he has used in the worst cases of almost complete paralysis of the legs and lower dorsal muscles, after the most troublesome contractures had been removed by tenotomies and extension. It consists of a strong padded corset to extend up the back, reaching almost to the axilla, and sustained by shoulder bands. On each side, somewhat above the hip, are attached pieces to sustain the legs; they reach to the feet, and bear on their inner side the shoe for the reception of the paralytic foot. At the hip-joint there is a flexion hinge, and above that an abduction hinge. The knee can be bent, but is secured by a spring that fixes itself firmly in extension. The splints run inside the limbs, and broad, well-padded rings fix the legs.

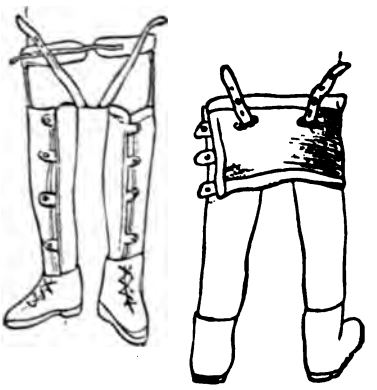

Fig. 379.—Heusner's Supporting Apparatus.

Operative procedures (tenotomies, division of fasciæ, etc.) are frequently necessary before the deformity can be overcome and before we can proceed to the second part of the treatment, the artificial replacement of the function of the limb. Recently other operations have been devised to artificially fix the useless limb and to make it a serviceable support for the body. Albert[8] has designated as arthrokleisis (artificial production of ankylosis, arthrodesis) a series of very successful resections for the fixation of the affected limb, both in the upper and the lower extremity.

Quite recently J. Wolff[9] has described an interesting case of arthrodesis operation in a boy five years old suffering with complete paralytic relaxation of the limb after traumatism.

Winiwarter[10] reports the case of a ten-year-old boy with completely paralyzed lower extremities (infantile spinal paralysis). He formed an artificial ankylosis of the knee first on the right, and a few weeks later on the left side. He then did the same with the tarso-crural joint. As the child died later

of diphtheria he had an opportunity to s
existence of complete bony ankylosis.

V. Lesser, Nicoladoni, Rydygier have
tion for paralytic foot contractures (see a

By congenital spastic rigidity of the lin
modic muscular contracture, or Little's[1]
group of symptoms characterized chiefly
certain groups of muscles occurring with
sive motion, with increased tendon reflexe
ing of the faradic contractility. The prep
of the adductors and flexors of the leg ca
gait, and a deformity of the foot due to s
sis.

Delpech observed the disease; but Litt
cases, and first recognized it as a disti
meyer, Busch, Benedict, and Rupprecht
Seeligmüller, Seguin,[13] Bradford[14] and ot
special cases.

The pathological processes which cau
probably very various. Little believed it
rhages into the brain and cord occurring i
to sclerotic processes; Benedict saw the
leading to atrophy; disseminated sclerosi
eral columns, cortical defects, etc., have
is some bulbo-spinal or cerebro-spinal le
complicated births are usually associated

It is frequently first noticed when the
ficulty in learning to walk. It may be th
the child can move at all. There is no
cular spasm on attempted motion. Bru
also evokes it. The tendon reflexes are i
bility is normal, though psychic abnormit
and articulation, laryngismus and spastic
present. There are, however, no trophic

The gait is the opposite of that of para
knees are bent and flexed and the heels
short, tripping walk, for the spasmodic n
stiffens the legs. The toes are turned in
the patient treads upon their tips.

Rupprecht[15] thus characterizes such
patient can painfully walk a few steps; l

ately falls stiffly to one or the other side. If he attempts to grasp anything, there occurs slowly alternating hyperflexion and flexion and finally clinching of the hand. If we attempt to passively move elbow, hip, or knee-joint, it can only be done by overcoming the elastic resistance or the clonic contractions.

To a certain extent the symptoms are similar to those of a compression-myelitis, from spinal caries; but this latter may be distinguished by the deformity of the spinal column and the posture of the trunk. Infantile paralysis is distinguished by the diminished or abolished faradic contractility, the galvanic degeneration reaction, the absent reflexes. A mistake for the acquired form of spastic spinal paralysis is more liable to occur.

The prognosis is unfavorable. Nevertheless, there occurs in many cases a spontaneous diminution of the symptoms. Treatment does much to improve these cases.

The constant current and the cold water cure have been recommended by Erb. Little recommended passive motions and a redressing splint-bandage. Adams and Busch employed a plaster bandage with advantage. Rupprecht used during the night lateral extension, a splint-bandage with dorsal flexion of the foot piece, and a Scarpa's shoe with elastic traction.

Tenotomy is of great value here, improving the walk markedly. The heightened irritability of the tendons when stretched disappears, and movement of the astragaloid joint returns permanently (Rupprecht).

Paralyses of special nervous and muscular areas, pathological or traumatic in origin, may cause certain characteristic deformities. Especially is that the case with the upper extremity.

The ulnar nerve supplies the flexor ulnaris, gives branches to the flexor dig. prof., the muscles of the ball of the little finger, the small flexor, all the interossei, the two innermost lumbricales, and partially the adductor pollicis.

Hence in paralysis of ulnar origin we get ulnar flexion and abduction of the hand, the bending of the three last fingers is hindered partly or wholly, and movement is so interfered with that writing, drawing, etc. is difficult if not impossible.

If the paralysis has lasted long, we get besides the "clawed" position of the hand, *the main en griffe* (caused by

the extensor dig. comm.), a characteris
The ball of the little finger disappears, an
its place; the region of the adductor polli
between both hollows the flexor tendons a
bundles of the lumbricales, innervated b
form a prominent cord traversing the pal
two last phalanges are flexed; the first
tended). Even dorsal subluxations of th
occur; while on the back of the hand the a
ossei causes deep furrows to appear betw
bones.

The median nerve supplies the flexor
part of the flexor dig. comm. prof., the f
abd. flexor brev., the opponens pollicis, an
ball of the thumb with the exception of th

Paralysis of median origin seldom occ
erally part only of a cerebral paralysis.
by inability to bend the second and thi
second and third fingers, and inability to
thumb; while flexion of the first phalan
can be effected by means of the interossei.

Hence the thumb is extended, adduct
index finger is extended, while the thre
slightly flexed in the normal position. Th
mand" posture. Further, deepening of
hand, prominence of the first metacarpal
of the atrophy of the ball of the thum
flexor surface of the fore-arm, are the la
the lesion.

Most important of all, orthopedically, i
origin.

The radial nerve supplies the anterior
the anconeus, supin. longus, ext. radiales
dig. comm., dig. V., ext. ulnar., ext. long.
abd. poll. long., and ext. poll. brevis. Henc
paralysis of traumatic or other origin, th
thumb is bent under it in adduction, the
flexed, extension and abduction of thumb
impossible, and supination of the extende
help of the biceps) cannot be accomplis
paralysis causes the approach to each oth

insertion of the flexors; and from the added interference with their function and the paralysis of the thumb, the hand becomes almost useless.

The atrophy of affected muscles in old paralyses of this kind causes flattening of the fore-arm upon the extensor and supinator side, and wrist-drop.

Fig. 380 shows a case of partial radial paralysis from chronic lead-poisoning.

Lead-poisoning occurs in painters and also from the use of

FIG. 380.—Position of the Hand in Lead-paralysis.

lead-containing face preparations (bloom of youth, Sayre). There is extensor paralysis of the hands, which hang down relaxed when the elbow is flexed. The complete impossibility of extension, usually bilateral, gives us a typical picture of an affection which is not likely to be confounded with any other. Besides the use of electricity, iodide of potassium (one to two drachms daily), orthopedic apparatuses are of use. Elastic extension may replace the extensors, and hence prevent nutritive shortening of the healthy flexors. The old Delacroix[16] apparatus is very useful.

Hudson has invented a light and elega
Sayre recommends.[17]

Collin's apparatus is excellent, and is c
ance with a plaster model of the hand an

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CHAPTER IX.

ORTHOPEDIC AFFECTIONS FOLLOWING FRACTURES AND LUXATIONS.

UNREDUCED luxations and improperly treated fractures fall within the domain of orthopedics.

Improperly set fractures consist of union in false position, either from not properly remedying the original displacement, or from secondary displacement during the period of healing. Hence there remains angular union, axis rotation, or overriding of the fragments.

The importance of the condition varies with the grade of the deformity. It is more serious when it affects the lower extremity, when it more frequently requires our care. Gurlt collected 149 cases affecting the lower extremity, 71 being of the thigh and 59 of the leg, against 12 of the humerus and 7 of the fore-arm. Bruns[1] collected 330 cases, 275 of them affecting the lower, and 55 the upper extremity.

FIG. 381.—Deformity Following Epiphyseal Fracture of the Humerus.

Etiologically the fracture may not have been noticed, or no attempt at replacement may have been made, or the retention may have been insufficient from looseness of the dressing or restlessness or delirium of the patient. The muscular peculiarities of the part influence the form of fracture markedly. Thus Bruns found that almost all the faulty fractures of the thigh were situated in the upper half of the bone and were angular outward with shortening. In children, in particular,

fractures are not infrequently overlooke epiphyses; for the displacement frequentl the absorption of the large amount of (Fig. 380).

The disturbance caused consists first the direction, length, and shape of the p cially in the consequent diminution or ab tion. And this is not alone the case in th extremities; in exceptional cases we may remedy the results of lesser injuries becau of the bone caused interference with mo mation and ulceration of the skin.

Treatment consists first in seeing th the most advantageous position possible breaking up the faulty union.

Where the union is not yet very firm elastic, the deformity may be remedied by of the callus. This is especially the case children, when, on taking off the bandage have not healed correctly, as not infrequ cially with the fore-arm. Duplay says sixt limit of the time after the injury in whi practicable.

In older cases we have the choice of mental osteoclasis, and 2, osteotomy or re

The earlier "Dysmorphosteo-palinklas zoli, etc.) allowed of but a very approxi their action, the newer osteoclasts (Robin precise in their action that it is not to b instrumental osteoclasis of badly healed coming into the foreground. Thus Pousse Manual osteoclasis is then reserved for ca children with the lesion in the middle of bone.

Where osteoclasis is impossible, as fr etc., osteotomy is in place; and especially osteotomy. This consists of the separa uniting the fragments, longitudinally if necessary, a bone-suture may be applied to Thus Fig. 382 shows a badly-healed supr of the femur causing genu varum, which v

osteotomy. Other operative procedures, such as tenotomy, are sometimes necessary.

In very extensive deformities the excision of wedge-shaped pieces[2] or partial resection may be indicated. When the ends of fragments project toward the skin, it is not infrequently necessary to lay the part open and remove the projection.

In the case shown in Fig. 381 there was ulceration of the soft parts over the sharp edges of the bone. I therefore removed the projecting edge of the diaphysis with the chisel.

Bruns, in seventy cases of antiseptic osteotomy (thirty-

Fig. 382.—Supracondyloid Fracture of the Femur with Consequent Genu-Varum.

Fig. 383.—Pseudarthrosis of the Tibia. (After Fergusson.)

Fig. 384.—Protective Apparatus in Recurrent Dislocation of the Shoulder.

eight linear, thirty-two wedge-shaped), records sixty-six cures without notable disturbance.

Pseudarthroses also may need orthopedic treatment; yet they hardly belong here. Probably where there is marked deformity connected with the condition, removal of projecting ends of bones, resection of both fragments with bone suture or screwing, will be proper; while retention apparatuses will only be employed for the mild cases.

As regards dislocations, the rare cases of so-called habitual luxation may need special orthopedic treatment. Thus Fig. 384 shows Le Fort's apparatus for habitual dislocation at the shoulder joint.

Old luxations also occasionally fall under the charge of the

orthopedist. Although few dislocations are nowadays to be regarded as irreducible, and though even for them arthrotomy and resection may be employed, there are yet cases in which a luxation has either not been recognized, or the patient has not sought medical aid at all. Here there may be considerable disturbance of function, either from faulty position (as in dislocations of the hip and the astragalus) or by pressure upon the nerves (as in axillary dislocation of the humerus). If the possibility of reduction can be excluded, to be determined rather by the condition of the limb than by the length of time that has elapsed, massage and manipulation may do much, especially in youthful individuals, to form a favorable neartrosis, and prevent ankylosis. In many cases, especially in the lower extremities, there will be no question of anything more than bettering the position of the limb. The accidental fracture of the neck of the femur in the attempt to reduce an old dislocation of the hip (Volkmann and others) has shown us how the abnormal position of the limb may be remedied by osteoclasis or osteotomy where, as in the upper limb, motility is of greater importance (at the head of the humerus, or radius). Resections of the head of the irreducible bone, division of adhesions, will give a fair amount of function. In this way entire resection of the joint will be less often necessary. These measures, to be done under the strictest antisepsis, are, however, no longer in the domain of orthopedics.

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CHAPTER X.

CONGENITAL LUXATIONS.

CONGENITAL luxations are conditions in which the normal relations of the bones composing a joint are disturbed. Though rare, they may occur at various joints: hips, knee, hand, shoulder, elbow, jaw, etc. The most important are those of the hips, which we shall consider somewhat at length.

Most of these cases are due to defective development of the articular head of the bone; rarely do intra-uterine joint affections, paralyses, or abnormal muscular contractions cause them. Since the idea of dislocation presupposes the former existence of normal joint relations, the designations of dysarthrosis cong. (Ammon), congenital malposition (Reeves)[1] would be more appropriate, especially as some of the most important elements of a dislocation, for example the rupture of the capsule, are absent.

Our scientific knowledge of congenital luxations begins with Dupuytren in 1826, though Hippocrates, Avicenna, Paré, Morgagni, Heister, and Paletta undoubtedly observed them. Dupuytren's pictures have been copied in most of the textbooks. Recent investigations show that the condition is by no means a very uncommon one.

By far the most important, as above stated, is the hip displacement (lux. coxæ congenita). It may, however, appear in earliest childhood. The femur is displaced upward and backward on one or both sides.

As regards the absolute frequency of the affection, Parise found it four time in 332 autopsies of new-born children, Pravaz saw 125 cases in sixteen years' practice, and Dopp, at the St. Petersburg foundling asylum, reckons one congenital hip dislocation to twenty-three children with club-foot. According to some observers, its frequency varies in different countries; Albert saw it exceptionally often in the Tyrol.

Hereditary influences are certainly
Schreger, and Stromeyer found. Obse
curred in several generations are by no
theless Adams found this to be the case
times.

Undoubtedly the affection is much
females. Krönlein found 87.6% of the ca
forty-seven females in sixty cases, Albe
in sixty cases. Roser explains this by
of the legs, which is much more likely t
during fœtal life. There is some differe
unilateral or *bilateral* occurrence. D
and others believed the latter to be mos
lein's combined statistics give only 40%
Adams, in his sixty cases, had forty-one

As regards the etiology, there is muc
idea that it is a developmental anomaly, t
ing undeveloped as a shallow furrow. I
be due to a premature ossification of th
in consequence of neighboring inflamm
Gravitz, though he found no calcificati
seven cases, yet supposes the occurrenc
ment.

While Adams and others think this
jority of instances—from the frequentl
rence of other malformations, if nothing
that there are other explanations for
they claim as etiological factors a pe
fœtus when there is pathological laxity
absence of liquor amnii (Roser, Lücke
looked upon fœtal joint inflammations,
Verneuil), or destruction of the capsule
Lavallée) or intra-uterine convulsions (

The idea also that traumatisms of t
or injuries during confinement[2] (Capu
congenital dislocation of the hip, has
Brodhurst,[3] especially, believed that i
breech cases. Sédillot regarded patholo
ligaments as the cause. Recently som
plained as due to paralysis of the ten
consequence of infantile paralysis, espec

Roser[4] have attempted to explain some instances as due to paralysis of the pelvi-trochanteric muscles. Verneuil[5] had previously stated that isolated paralyses and atrophies of the gluteal muscles, causing relaxation of the joint, were at the root of the trouble. The pathological findings are quite various. The Musée Dupuytren contains forty-nine specimens of dislocation of the hip, twenty of which are congenital. The variety depends upon whether the specimens belonged to

FIG. 385.—Preparation of a Lux. Coxae Cong. (Mus. Dup.).

children who had not learned to walk, or to adults. Most cases were originally incomplete luxations.

In the new-born, or in children who had not yet learned to walk, the acetabulum was mostly in the normal place, but shallower and smaller than usual, and with its posterior border flattened. The head of the femur also was flattened and atrophied, and rested on the posterior upper edge of the acetabulum. The lig. teres was absent or elongated and thin; the capsule was intact, perhaps a little relaxed; but there was no rupture of it, nor was there any other essential alteration of the pelvis.

Fig. 385 shows a preparation taken from a small child with

right congenital dislocation of the hip.
lengthened, and hypertrophied capsule; th
the small triangular shallow acetabulum
small conical head of the femur resting
upper border of the capsule—are all well
the lig. teres, or of the head and neck of
present in rare cases (Carnochan, Harris

In older children we see plainly that
not kept pace with the other parts in its
the head of the femur are small and mis
imperfectly developed or absent; and th
more the neck is placed rectangularly to
The capsule is toughened and stretche
serted; it permits great freedom of pla
femur, and is especially thickened wh
against it.

Now, since the rump sinks when t
stands, the thickened capsule and the lig
be eventually worn through. Hence, in g
either find great thickening of the capsul
the formation of a nearthrosis. Yet suc
attain the completeness of the nearthro
traumatic dislocations.

The pelvis undergoes characteristic
altered pressure relations. In unilateral
the affected side of the pelvis is atrophic,
from before backward and from above
Thus the illium is forced inward, and mor
ischium is displaced outward. With bila
the other hand, the pelvis is distorted s
ilia are forced inward, the pelvic entrance
ished in both diameters, and the transv
pelvic entrance is somewhat increased. E
why congenital dislocations do not int
(Bouvier, Lassman[6]).

The symptoms of congenital dislocati
in the disturbed gait, the uncertain motio

In bilateral hip-dislocation the child
late, and has a peculiar vacillating goose
trusion of the abdomen, marked flexion o
dosis. There is also elevation of the hi

fulness above and behind the region of the normal hip-joint (Fig. 386) caused by the displaced head of the bone; in older cases we notice the relative shortness of the lower extremities and the excessive breadth of the hips.

FIG. 386.—Bilateral Congenital Dislocation of the Hip.

In unilateral congenital dislocation of the hip the gait is oscillating and limping; the affected leg is shortened; there is inclination of the pelvis, and scoliosis of the spinal column.

The limb is weaker than its fellow, an
rotated inward.

The diagnosis of the condition is freque
is based on the excessive mobility of the j
and traumatic dislocations the joint is fixe
easily pulled back into the normal positi
lordosis and shortening.

From the slight amount of change that
conceivable why the affection is seldom
young children. Nevertheless Krönlein[7] r
at two days and at four months respect
absence of pain, swelling, fistula, etc., we fi
line above the side of the head of the fe
ence of other malformations, and the anam

The prognosis of congenital hip dislo
unfavorable in older cases. In very your
and Buckminster-Brown have reported fav
treatment; but these are certainly exceptio
we must be satisfied to prevent further
formity.

If the condition were more frequently
ately after birth, it would be more often p
position, as can be done in most cases of
delivery. At all events it would be pos
thigh in the most favorable position, by pa
obtain a favorable nearthrosis. Unfortu
portion of cases are seen only so late that
the question. For a long time our therap
sisted only in protracted extension.

Humbert, Jacquier, Guérin, Pravaz, E
others claim to have obtained favorable re
cures, by this means; while Dupuytren a
stress on a roborant treatment. Pravaz
apparatuses, the first to bring the head of
the acetabulum by extension, the second
ting out again, and the third to increase th
tabulum.

Very recently a case of cure has been
minster-Brown.[8] The treatment consisted o
rest in bed, with extension, passive mot
directions, and then the use of a wheeled w

Nevertheless, such cases are the exceptions; and in most cases tonic treatment, strengthening of the muscles, retention for long periods of time in the abducted position (Roser), give us most hope of preventing the affection from becoming worse.

For unilateral cases Taylor's coxitis machine, or other apparatuses resting upon the ischial tuberosities, and tending to prevent a further upward displacement of the head of the bone, are most appropriate. For double congenital luxation a variety of apparatus have been proposed by Dupuytren, Bouvier, Stromeyer, Heine, Froriep, Langgaard, Hüter, Schwabe, etc. They are all more or less on the style of the *cincture à godet* and consist essentially of a pelvic girdle with a hollow lateral pad, whose object is to prevent further upward displacement of the trochanter, and of a circular arrangement for fixing the thigh. The pads, as in Langgaard's apparatus, are fixed by a ball-and-socket joint to a firm rod attached to the pelvic girdle (Fig. 388).

Fig. 387. — Lux. Coxae Cong. in a 14-year-old Boy.

Fig. 388. — Langgaard's Apparatus for Lux. Coxae Cong.

In Kraussold's[9] apparatus the trochanters are fixed from above by movable concave pads which are attached to the pelvic girdle, and are supposed to fit in the region between the anterior superior spine and the trochanter.

The apparatus made by Schwabe[10] consists of a steel strengthened leather pelvic girdle accurately fitted after a plaster cast of the part, with arm pieces and a broad band over the stomach above connecting them, to correct the lordosis. A smooth polished pad, of ivory, hard-rubber, or ebony, is attached to the pelvic girdle. It can be turned in any direction, and with it any amount of pressure may be made downward and inward upon the trochanter. After putting on the apparatus, the patient is placed upon his back, the extremity is extended and the luxated head replaced, and the pad is fixed in the proper position.

All these apparatuses are dear and com
useless. "I have frequently seen childre
says Adams, "but have failed to observe
rived therefrom." It is therefore readil
corsets of silicate of soda and other plastic
tried. Thus Landerer recommends the a
sion of a silicate corset reaching from th
chanter; the trochanteric part is to be car
fore it dries, so as to make a kind of depres
then to be slit in front and behind.

Landerer found the working of these c
tory, the patients immediately appearin
inches taller, the lumbar lordosis being st
the bearing becoming normal. One patien
had before not been able to go at all, walk
immediately after its application. For the
386 I had a leather corset made after such
with the result that his gait improved rem

In those cases where paralysis of a cer
cles has caused the deformity, it is pro
strengthen them by electricity, massage
these are the cases in which hydrotherap
movement cure accomplish remarkable res

Guérin, Brodhurst, and others have reco
of the pelvi-trochanteric muscles, to remo
reposition which they occasion; but this ca
in very few cases. Buhring proposed to
bone, and others thought by subcutaneous
periosteum of the ilium to excite the bo
activity. Mayer seriously proposed to s
femur by resection; and Hüter recomme
atrophic head of the bone and removing it,
osteum from the neck of the femur and
stitching them together to obtain a synos
joint connection between pelvis and fem
that in any rational operation we must
head of the femur in a new cavity, perhaps
pegs; since even if in a unilateral disloca
the final result, this would be better than t
ity of congenital luxation. As regards rese
this deformity we possess a series of o

Heusner[11] in a female seventeen years old, after vainly trying Taylor's and other machines, did a resection, removing the elongated head of the femur and chiselling off the edges and enlarging the acetabulum, and obtained a good result.

Margary[12] also tried chiselling out the acetabulum, and has done seven resections for congenital hip dislocation (three unilateral, four bilateral). Rose and Reyher also were compelled to resort to it. For old cases, where the motion of the head upon the pelvic bones causes great pain and disturbance of function, the operation of resection is fully indicated, and has given good results, especially when combined with deepening of the acetabular cavity.

Congenital dislocations of the patella have been observed. They are mostly unilateral or bilateral, incomplete or complete external luxations. When complete, it is only when the knee is flexed that the dislocation becomes prominent or apparent (intermitting form); when incomplete, the patella lies upon the external condyle of the femur, and when the knee is flexed, the patella returns to its normal place. In a few cases the secondary genu valgum was so great, that operative treatment was necessary (Middeldorpf).[13]

Cases in point have been described by Paletta, Wutzer, Caswell, Boyer, Ravoth, and Bessel-Hagen.[14] The amount of disturbance was usually marked, especially on going downhill, or down-stairs. Suitable knee-caps were in most cases sufficient to relieve the trouble. Our main endeavor in treatment should be to gradually correct the position by passive flexion, fixation in the correct position, etc.

In congenital dislocation of the knee the tibia is usually displaced forward with abnormal hyper-extension of the joint; and this may be so great that when the child lies upon its back it may be possible to extend the leg vertically or even to make the anterior surfaces of leg and thigh meet.

Congenital luxation of the foot has also been noticed (v. Volkmann).

Rarer and much less important are the congenital luxations of the upper extremity. Probably most of the cases of congenital luxation of the humerus described by R. Smith,[15] Mayer, and others were of a paralytic nature (Little, J. Wolff). At the elbow there were chiefly noticed isolated congenital luxations of the head of the radius, which, like those of the

hand, mostly depend upon defects in and disturbances of development in the region of the fore-arm.

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